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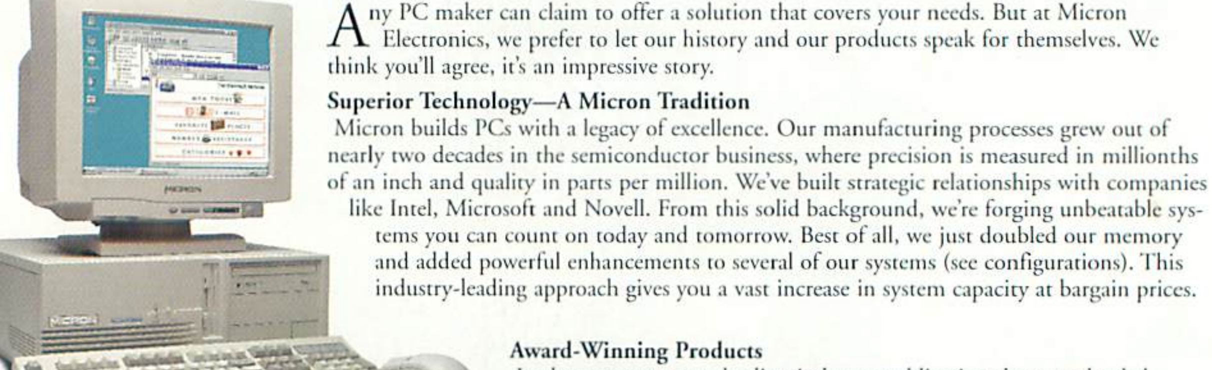
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Any PC maker can claim to offer a solution that covers your needs. But at Micron Electronics, we prefer to let our history and our products speak for themselves. We think you'll agree, it's an impressive story.

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Micron builds PCs with a legacy of excellence. Our manufacturing processes grew out of nearly two decades in the semiconductor business, where precision is measured in millionths of an inch and quality in parts per million. We've built strategic relationships with companies like Intel, Microsoft and Novell. From this solid background, we're forging unbeatable systems you can count on today and tomorrow. Best of all, we just doubled our memory and added powerful enhancements to several of our systems (see configurations). This industry-leading approach gives you a vast increase in system capacity at bargain prices.

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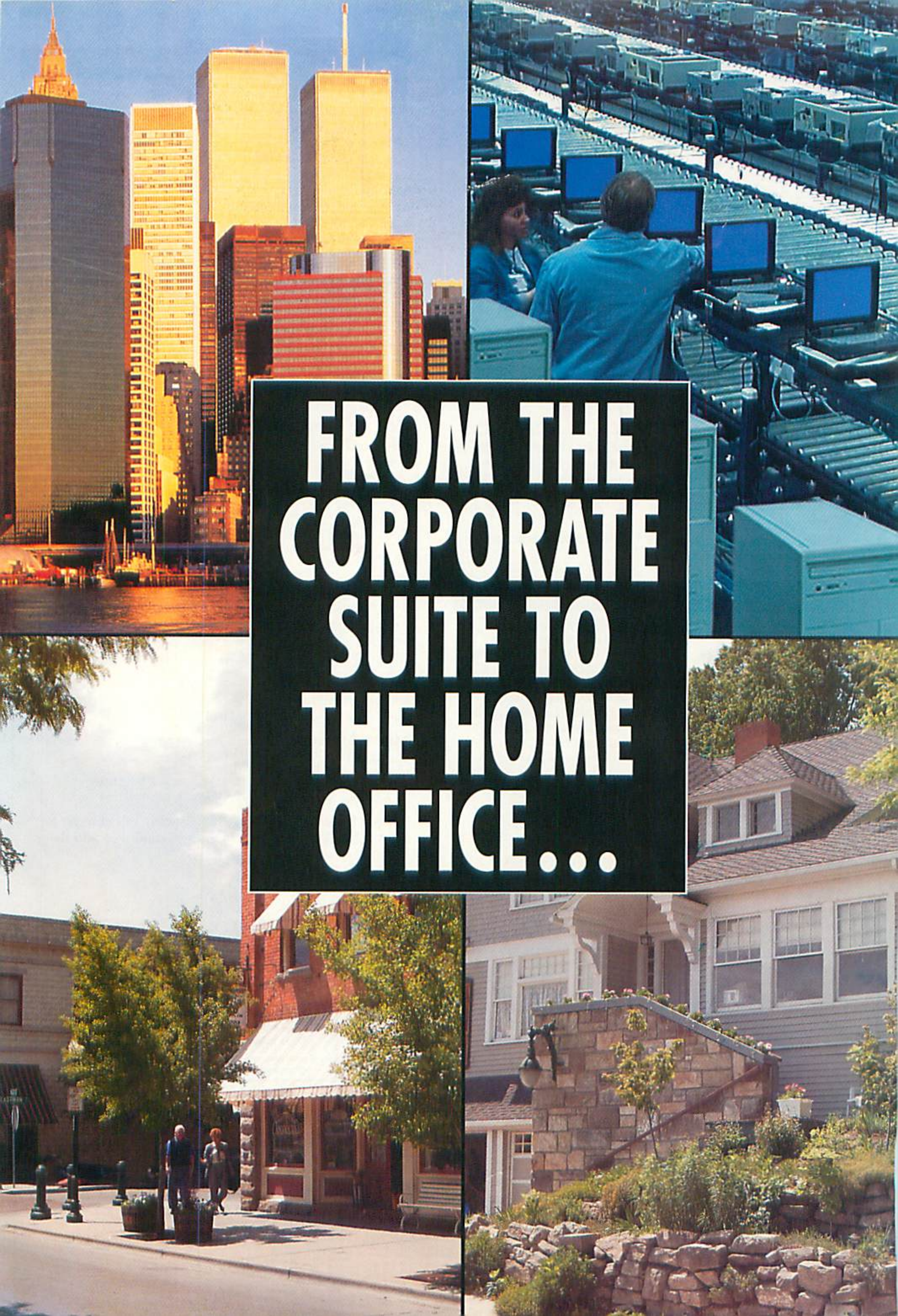
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Source: PC World Reliability & Service Monitor, May 20 - November 20, 1995


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  Internet Explorer
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- PCI 64-bit 3D video, MPEG, 2MB EDO
- 15" Micron 15FGx, .28dp (13.7" display)
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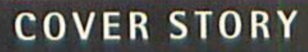


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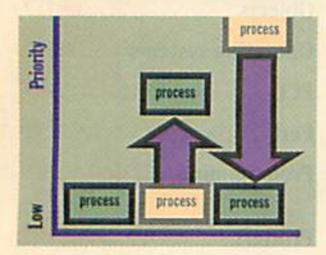


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Because bad power takes make sure new Back-UPS®

Guaranteed Protection against all power problems, on all power paths, for your PC and peripherals.

LIFETIME EQUIPMENT PROTECTION $25,000

Back-UPS Office's compact design installs easily on desktop, floor, or mounts to wall. Its ninety-degree plug fits flush against the wall.

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Back-UPS Office provides enough outlets to protect your entire system. Six outlets guard your hardware with full time surge protection. Three of the six outlets provide instantaneous battery backup to keep your system from crashing in the event of a brownout or blackout.

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An LED signals when the Back-UPS Office's internal self-test finds the battery near the end of its life. You have 6-8 weeks replacement warning. Batteries typically last 3-6 years, and are user-replaceable.

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Without a proper ground, most surge protection is useless. Back-UPS Office alerts you to wiring problems such as missing ground and reversed polarity, two common wiring mistakes which otherwise would require an electrician's visit to diagnose.









APC products have won more awards for reliability than all other UPS vendors combined.

multiple paths to your PC, Office™ gets there first



Protect ME! with APC

Bringing up the issue is awkward, but inevitable: You have a better chance of winning the lottery than of escaping power problems. Sooner or later, every computer user learns about surges, brownouts, spikes and blackouts. Unfortunately, most learn the hard way. Power problems are the single largest cause of computer data loss and hardware damage. If a power sag makes your modem drop the line while you're downloading a file from the Internet, or causes your keyboard to lock before you've saved work, you lose time, money and end up spending another late night at the office to meet your deadlines.

Multiple peripherals and data lines to and from your system are vital, but dangerous. Without them, you can't do your job. However, plugging a phone line into your computer doubles your vulnerability to power problems; add any peripheral, and it triples. Even if your computer's AC power-line is shielded, when a surge hits an unprotected peripheral, it can blaze down serial and data lines, and toast your expensive PC.

Only Back-UPS Office provides single device Multipath™ protection for all your equipment

...he Multipath™ Power ...otection Advantage	Traditional Surge Protector	Traditional UPS	Back-UPS Office
...otected Paths			
AC	•	•	•
Data			•
Phone			•
...tal Outlets	7	2	6
...umber of Block Outlets			2
...otection from			
Surges	•	•	•
Spikes	•	•	•
Blackouts		•	•
Brownouts		•	•
Overvoltages			•
...pical Runtime in Minutes			
with Pentium 100 w/15" monitor		10	10
...attery backup for			
PC		•	•
Monitor		•	•
Storage Devices/Zip Drives			•
...ll-time surge protection for			
Fax/Modem	•		•
[illegible]	•		•

Traditionally protecting all your equipment meant buying both a surge suppressor and a UPS. Even then only your AC line was protected. New Back-UPS Office protects all the paths to all your equipment.

Only Back-UPS Office provides true common ground protection

Figure 1

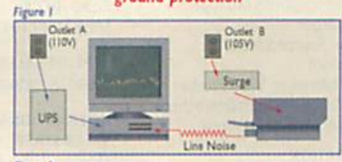


Figure 2

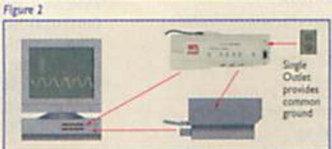


Figure 1: voltage differentials between multiple outlets create line noise and data glitches.
Figure 2: Back-UPS Office's common ground design eliminates the danger of voltage differentials.

Until now, protection for your entire system required several devices. But multi-device protection can leave you vulnerable to line noise and unwanted data glitches created by voltage differentials between outlets.

Back-UPS Office provides reliable, true common ground Multipath™ protection for your entire system. Instantaneous battery backup ensures uninterrupted operation of your CPU, monitor and external storage devices. Full-time surge suppression spreads a safety net around any remaining integrated peripherals, like modems, printers, speakers, and phone systems. Back-UPS Office's convenient BlockSafe™ outlet spacing handles all size plugs.

Back-UPS Office protection means true Multipath™ protection, clean, safe power to every peripheral, and instantaneous battery backup to keep your cutting edge system and O/S from crashing. It means protection for less by integrating the security of a surge suppressor with the power of a UPS, guaranteed up to $25,000.

Protect yourself before you kick yourself. Get your new Back-UPS Office today (list price: $179.99), or call APC for a FREE 60-page catalog!

Convenient BlockSafe™ Outlet Spacing
Back-UPS Office's outlets are spaced to accommodate all size plugs, including large transformer blocks. You don't have to sacrifice the use of any of your outlets if you use block plugs.

Internet Ready Fax/Modem Protection
Back-UPS Office's built-in phone line/10 Base-T network cable surge protection prevents data line surges from damaging internal and external modems, motherboards, input/output cards, and other system components.

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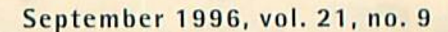





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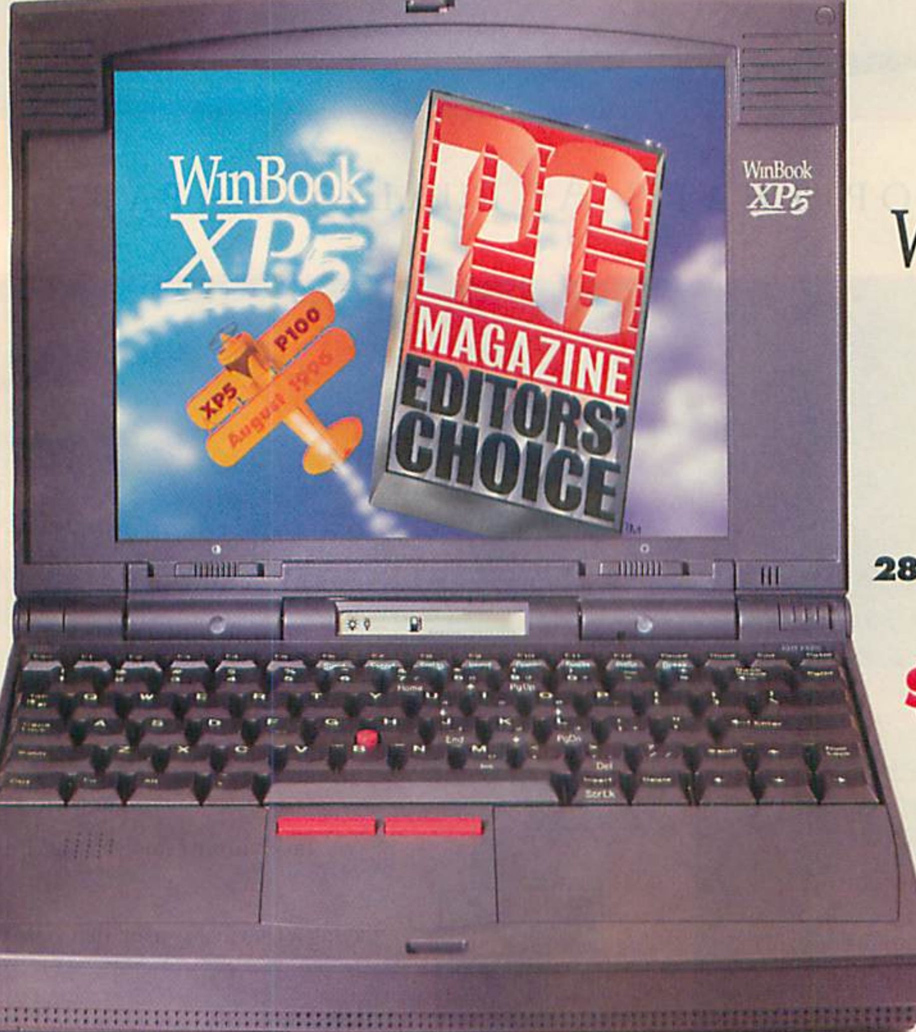
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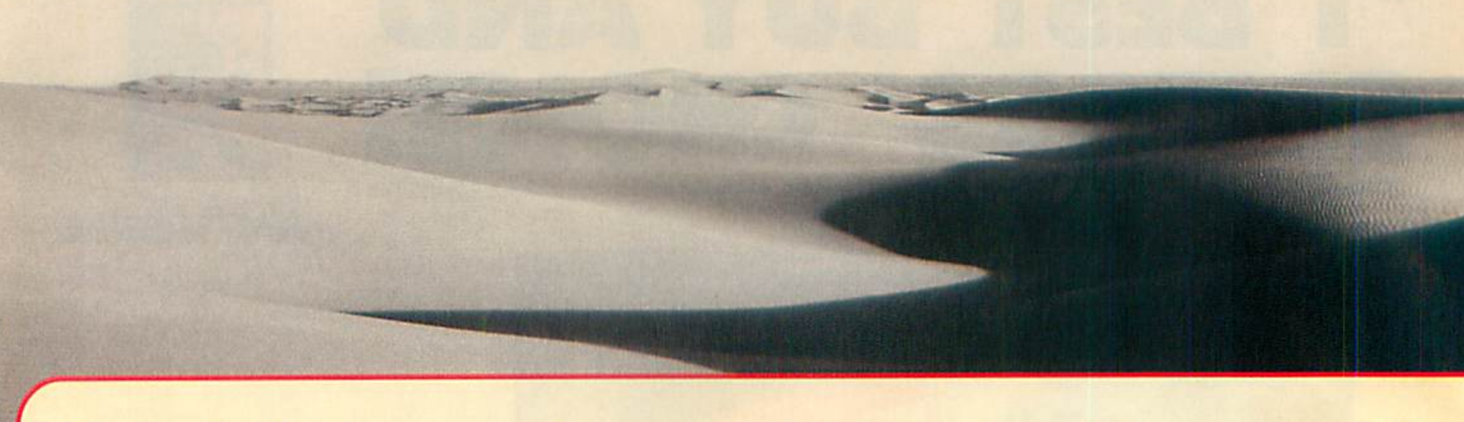
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Has It Changed Your Life Yet?

editorial

Smart, Fast, and Well Connected

A 180-MHz Pentium Pro is no longer enough, as our sense of what speed and intelligence mean changes dramatically.

I bought a new computer recently, a Pentium Pro 180. With a processor like that and 32 MB of RAM, nothing can stop it—except the Internet. When touring the global village, it turns out, we must park the sports car and walk at only 28.8 Kbps.

So it was with a sense of anticipation that I went to Boston College to try out its new network. What's new about it is that thousands of students and faculty members are using Continental Cablevision's trial 12-Mbps Internet service. I sat at a low-end Mac (an 80-MHz PowerPC 601) and blazed away on-line. A large file transfer that my home machine estimated at 1 hour and 20 minutes took just 3 minutes. Complex Web sites like Disney's, Silicon Graphics', and Adobe's were usable within seconds.

Cool. But beyond fast, the experience made me realize that the type of broadband Internet access we discuss in this month's Cover Story is a significant step in the overall evolution of computing.

These students are experiencing what it would be like if the whole world were on Ethernet. Twenty years from now, I hope we'll all be computing on one unified, digital network. Wherever we are, we'll transmit by voice, image, text, or whatever else we come up with.

What are the vital components of an intelligent network? Here's a stab at it:

- *One identity*. How many phone numbers, fax numbers, e-mail user names, and other log-on numbers do you have? How about one that you could use anywhere? Then anyone could reach you through that one ID. The network would know how to find you.
- *Universal accessibility*. Through some combination of landlines, wireless, and satellite, we need to stitch together a truly global, inclusive network. No matter how many network service providers there are, they'll all need to give us access to that network.
- *Full interchange between digital text, voice, fax, and video communications*. Our computers are already capable of handling all those media. Now we need network connections and software that give us a common interface and the ability to readily transfer information between communications types. The computer represents the highest common denominator among network instruments; we can always choose to downshift to send information to people who have only telephones or fax machines.
- *Protocol transparency*. Let the network translate—applications and end users should never have to know what protocol their recipients are using.
- *Consistent high performance anywhere*. Someday, the type of performance that Boston College students have now may be considered the backwater of the global village. However, if that's as bad as it gets, the intelligent network will be practical for everyone. With the advent of asynchronous transfer mode (ATM), it will be flexible enough to deliver the right performance for each different use.

The blazing network performance BC has now may one day be considered the backwater of the global village.

What does this wish list add up to? A world where you can log on anywhere as the same person, access information no matter what form it's in, and get it at least as quickly as if it were local.

Boston College is halfway there. Students get a personal phone number that stays with them for four years, regardless of where they live. For data, they have an IP address, which gives them access anywhere on Boston College's totally flat, bridged network.



PHOTOGRAPH: KELLIE WALSH © 1996

Broadband networks such as Boston College's cable backbone lay the groundwork for ubiquitous intelligent networking. What remains is for our industry to agree on standards and technologies that give you one logical address to access it anywhere.

Until that happens, I won't be satisfied with just knowing how fast or feature-rich a new technology is. I'll want to know how much closer it takes us to this holy grail of an intelligent network.

Mark Schlack

Mark Schlack, Editor in Chief
mschlack@bix.com



"I started running OS/2 Warp Server on all my networks and guess what?

My rainy days are over."

Consolidate

It was time to think about consolidating the company's mixed environment network onto a single operating system. That's why Steve Conaway, Director of Computer Services at the Financial Times, decided to check out the new release of OS/2® Warp Server.

In no time at all, Steve was waxing poetic over OS/2 Warp Server's ability to handle blockbuster-sized databases and make Internet and intranet access a breeze. He was also impressed with all the advanced printing capabilities and management features that simplified the running of both his network and his life. Which is why Steve now thinks of OS/2 Warp Server as his umbrella network operating system.

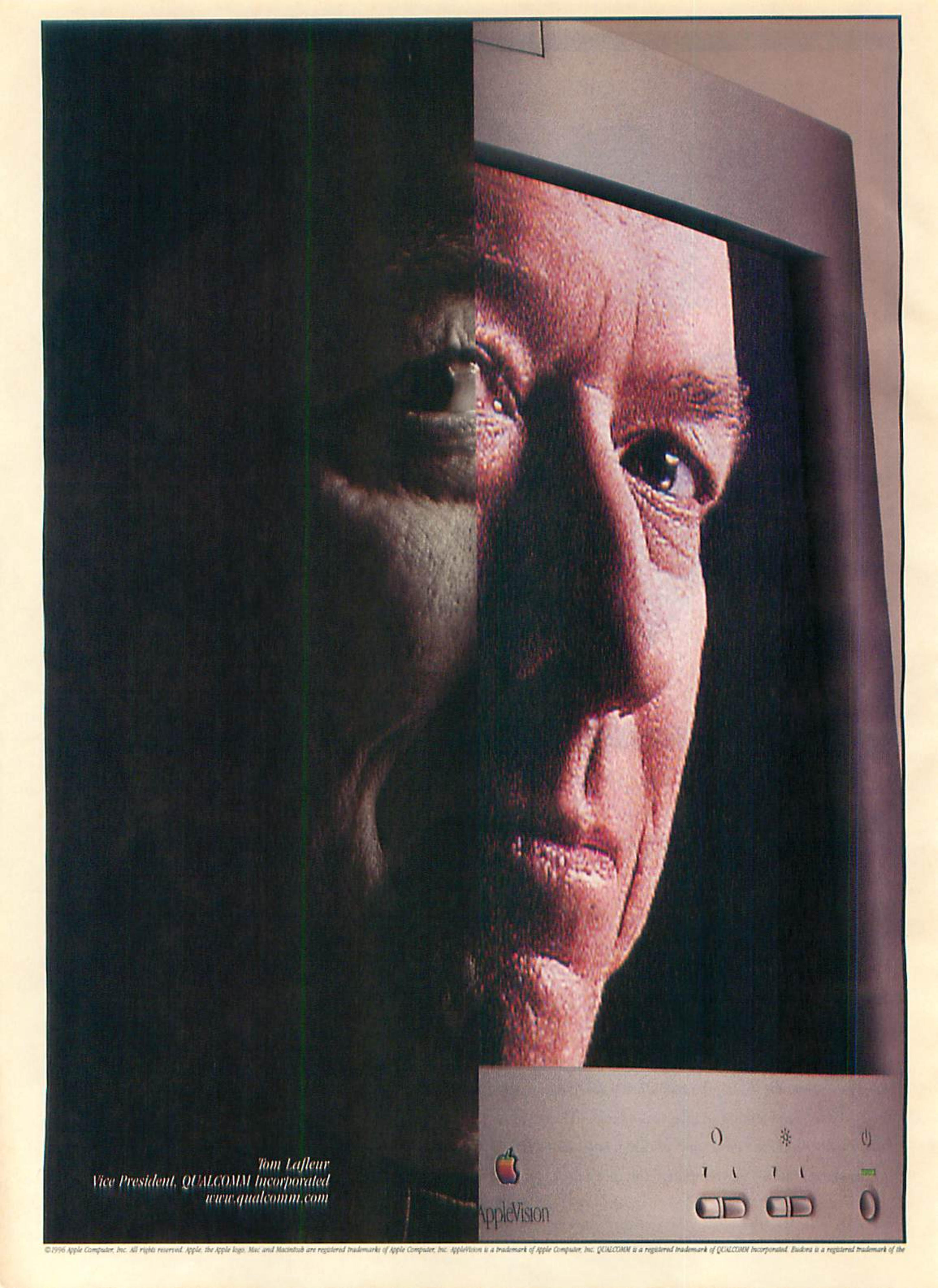
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IBM

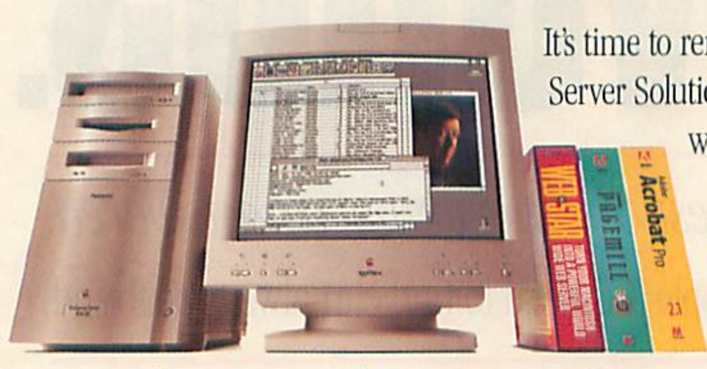
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Inbox

The Core of BYTE

I don't read BYTE as an alternative to either the news-rag weeklies or the PC-specific periodicals. What I count on from BYTE is in-depth technical information about where things in the industry are—or even might be—heading. Dick Pountain's articles are one example. The Core section of the June issue is another. If I can keep getting that type of information, I'll keep resubscribing.

Kevin J. Slater
Slater Programming Services
Glenshaw, PA
kslater@pobox.com

Big Blue Electric Money

Udo Flohr's timely article on "Electric Money" (June cover story) correctly points out the important role that secure payment mechanisms are playing in promoting electronic commerce over the Internet. As the article notes, IBM has held a leading role in this field, beginning with our original work on the Internet Keyed Payments (iKP) protocol, and more recently through our continuing collaboration with MasterCard and Visa on their Secure Electronic Transactions (SET) protocol. But I would like to make one important clarification: IBM's efforts have been dedicated to fostering secure commerce over the open public Internet, as well as over private networks. IBM was instrumental in getting Visa and MasterCard to merge Secure Electronic Payment Protocol (SEPP) and Secure Transaction Technology (STT) to come up with SET. Your article mentioned only Microsoft and Netscape as SET technology partners. IBM is one of the leading providers of SET technology, having demonstrated working SET code at Internet World in April, and we will deliver SET-compliant solutions for consumers, merchants, and banks this fall. IBM is fully committed to SET.

Mark Greene
Vice President, Electronic Payments
IBM Internet Division

E-Cash Ain't Nothin' But Trash?

Anonymity is an illusion in a workable "electric money" system. Existing money systems create a paper trail of receipts, canceled checks, warranties, and the like. In legal cash transactions, a customer obtains a receipt and merchandise. Consider sending currency through the postal system: 1) It can be lost or stolen, and 2) you cannot verify payment. International jurisdiction aside, how does the customer prove that the merchant received payment? Stated differently, which entity has the ability and desire to enforce anonymous (read: untaxed) transactions? Remember that any system of verifying transac-



tions between parties is, by definition, no longer anonymous. Which customers will use a system that guarantees privacy but not delivery of purchased goods? Attempts to build anonymity into transactions are misguided if the Internet community wants to stimulate legitimate business.

Patrick A. Traichal
Assistant Professor of Finance
University of Texas at El Paso
ptraicha@utep.edu

Fortunately, the approach to anonymous e-cash developed by DigiCash's David Chaum seems to work. Yes, someone could take advantage of the fact that payments were unverifiable, but unverifiability is precisely what some people want, at least for some transactions. So far, anonymous and verifiable implementations coexist. —Udo Flohr, contributing editor

Am I the only one horrified by the notion of electric money? Aside from the neat way it divides us into desirable (affluent and technologically savvy) and undesirable (technopeasant) markets, it represents a mortal threat to personal liberty. Any electronic trace linking purchaser to transaction, be it a credit card record or cybercash, provides grist for the information mill. Many people were alarmed when Supreme Court nominee Robert Bork's preferences in videotape rentals were leaked during his confirmation hearings. Imagine running for office, or opposing a land developer or corporate polluter, only to find your alcohol purchases, your preference in magazines and books, your eating habits—absolutely everything—disclosed publicly. The rise of cybercash will accelerate the transfer of political and economic power from individuals to giant corporations by making our lives even more transparent

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than they are now.
Geoffrey Wittig, M.D.
Dansville, NY

The reality is that people want to buy and sell over the Internet. If society reaches a point where all money is digital, it will be a nightmare—but I don't think it will come to that. Let's hope there will always be alternatives.
—Udo Flohr

Programming for MMX

Tom Halfhill's "x86 Enters the Multimedia Era" (July CPU column) was very informative. However, a problem he describes might not be real. On page 60 he says that "Programmers can use MMX and FP (floating-point) instructions in the same program, but they'd better not mix them because both kinds of instructions need the same registers"; and that multimedia developers "should segregate MMX instructions in a subroutine or library that's called only after probing the chip's CPU_ID to verify that it supports MMX." The first statement must have been directed to programmers writing compilers or x86-specific assembly-language (or machine-language) library routines. Programmers using a compiler or smart assembler that can generate code properly for an MMX-equipped CPU would not have to be aware of this: The tool would save and restore register contents properly to reuse the registers. Possibly, the programmer would only have to know to use the proper tool option for the target CPU. At run time, the library routines would do the CPU probing. I don't think one should assume a priori that a programmer would never want to execute a mixture of MMX and FP instructions on the same register data. Computing hardware-control-register mask bits might require it.
John Michael Williams, Ph.D.
Redwood City, CA

Unfortunately, no compilers currently available have high-level language support for MMX. To use MMX, programmers must embed inline assembly code into their C or C++ source code. It's the programmer's responsibility to manage the x86 registers shared by MMX and FP instructions. If the programmer doesn't clear the MMX registers (by using the Empty MMX State instruction) before executing an FP operation, the results could be disastrous. Even if compilers do eventually provide high-level support for MMX, it would have to be an awfully smart compiler to reschedule FP instructions that a programmer carelessly mixed into an MMX routine. It's unlikely that MMX and FP instructions would need to operate on the same register data; they use the registers in different ways. FP instructions see a push-pull stack of 80-bit FP values; MMX instructions see a random-access file of 64-bit integer values. However, x86 programmers are infamous for their crazy coding, so I suppose anything's possible.
—Tom R. Halfhill, senior editor

What, No FoxPro?

In the review "New Leaders of the Client/Server Migration" (June), you covered Delphi, PowerBuilder, SQL Windows, and Visual Basic. I am shocked and astonished that you did not cover Visual FoxPro! I use it and feel that it is equal or superior to all the other mentioned tools for client/server development. What gives?
Bruce Ritter
bruce_ritter@halcyon.com

Our focus was not on general-purpose application development, but specifically on the products' capabilities for developing client/server front-end applications. For general-purpose application development, Visual FoxPro is certainly a major player, but when it comes to building client/server front-ends, it is not on the same level as the products we evaluated. The vendors, with whom we had lengthy discussions about the focus of our review, never raised the issue of including Visual FoxPro. When we asked Borland, Powersoft, and Gupta what products they considered to be their major competitors in this area, they all mentioned Visual Basic; none mentioned Visual FoxPro. Perhaps more significant, never at any time did Microsoft representatives indicate to us that they felt Visual FoxPro should be included in this comparison.
—Mark Hettler, senior technical editor, NSTL

Faster Backups

In May's Lab Report "16 Drives for Fast Data Backup," the Iomega Jaz drive had the fastest average seek time, fastest average access time, fastest synchronous burst-transfer rate, and fastest maximum sustained read/write transfer rate. Why did NSTL not judge it the best removable-media drive? On what did you base your performance scores? The Jaz was clearly much better than any other drive.
Richard K. Seltzer
102756.711@compuserve.com

The comparison rated only the 5¼-inch optical drives. We treated the Jaz drive and other 3½-inch storage devices in a separate section intended to cover a lower-cost alternative. That said, the Jaz drive is indeed quicker than the top-rated optical drive because it's built on magnetic media, which is similar to standard hard disk technology. Magnetic drives can read or write data in a single pass of the head and have faster rotational speeds than optical drives. Optical drives have larger heads and slower spin rates, and most need three passes to write data, but they offer greater storage capacity and longer life than magnetic-media devices. —Eds.

Web Lessons Learned

Thanks for another good Web Project column (July). One thing I would urge you to consider is regular Hypertext Markup Language (HTML) validation. The necessary Standard Generalized Markup Language (SGML) parsers are available at ftp://ftp.math.utah.edu/pub/sgml in both source and precompiled binary forms. The htmlncheck script provides a convenient interface to the SGML parser, nsgmls. It is regrettable that so few Web pages actually conform to the HTML grammar; humans definitely cannot get it right by hand, nor does most HTML-producing software. Too many people are jumping on the Netscape bandwagon and using extensions that are not part of the grammar and

may be implemented by only one, or a few, browsers. With adherence to a rigorous grammar, we can have some confidence that our Web pages will be correctly viewable everywhere and will also be parsable by other software.

Nelson H. F. Beebe
Center for Scientific Computing
University of Utah
Salt Lake City, UT

I've recommended HTML validators in the column. But I confess I've had a hard time integrating the rigorous use of them into what I do. I should, I know. Thanks for the reminder. —Jon Udell, executive editor

FIXES

In the features table accompanying "12 Ink-Jet Printers for Quality Color" (June), we should have indicated an RS-422A LocalTalk port as well as a parallel port on the HP DeskJet 850C.

In the text box on page 76 of "Groupwar Strategies" (July), we referred to Uptime Computing Solutions. The correct name of the company is Uptime Computer Solutions.

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COVER STORY:
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Realistic, low-cost, 3-D graphics are about to become commonplace on the desktop. We'll look at new graphics hardware, software standards, ways to use this power in applications, and implications for the on-line future.

STATE OF THE ART:
LARGE-SCALE NETWORKS
BYTE looks at the whole picture, from design to testing and simulation methodologies, maintenance, and network management.

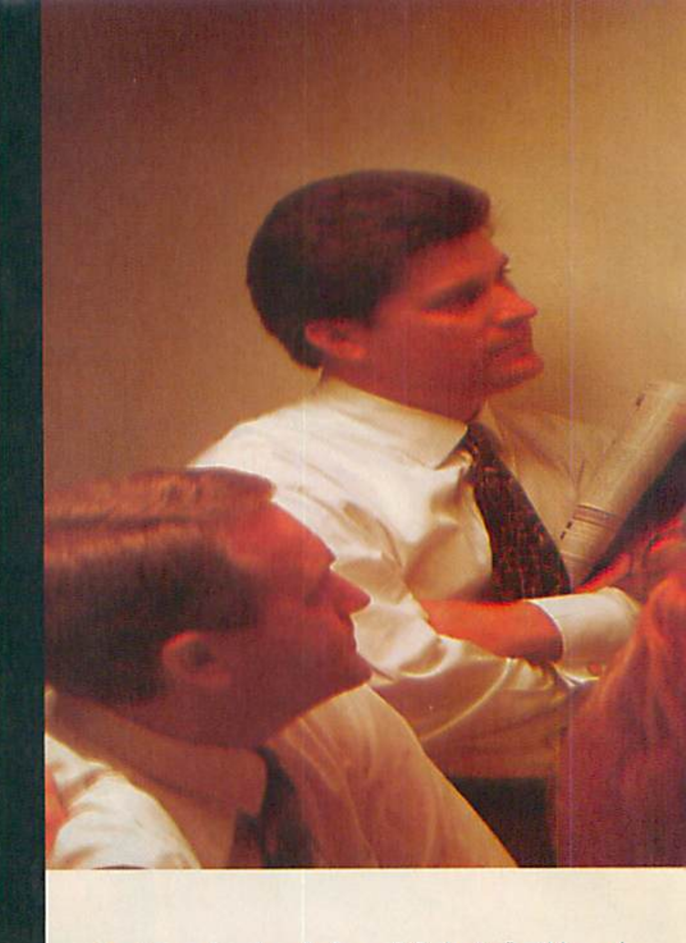
CORE:
A VERSATILE NEW I/O PROCESSOR
It's an I/O processor and bus bridge for server design: Intel's i960 RP manages compute-intensive tasks and implements a PCI-to-PCI bus bridge.

REVIEWS:
CUTTING-EDGE BACKUP SOFTWARE
Backing up doesn't have to be boring. We'll review leading-edge programs that offer powerful options such as image and application backup.

OBJECT-ORIENTED DEVELOPMENT
Taking object-oriented development to the next level, Siemens Nixdorf's ComUnity is a promising component-based framework. Our reviewer test-drives the very first version, which is designed to work with Visual Basic 4.

NSTL HARDWARE LAB REPORT
NSTL tests Pentium-based multimedia notebooks from Compaq, Dell, Hitachi, IBM, Toshiba, and other leading vendors.

WHEN THE JOB CALLS FOR A PRO





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- ✓ Priced right

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- 2nd Tier Reliab
- High pr

GATEWAY

- 3 year limited warranty
- High price

ClientPro™ P100

- Intel 100MHz Pentium® processor
- 256KB pipeline burst cache, flash BIOS
- 3Com 3C509 Combo network adapter
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- Microsoft Office Pro 4.3 preinstalled

$2018 Bus. lease $69/mo.

- With 133MHz Pentium processor..........add $100

ClientPro P200

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- 32MB EDO RAM
- 3.1GB EIDE hard drive
- 3.5" floppy drive
- 8X EIDE CD-ROM drive
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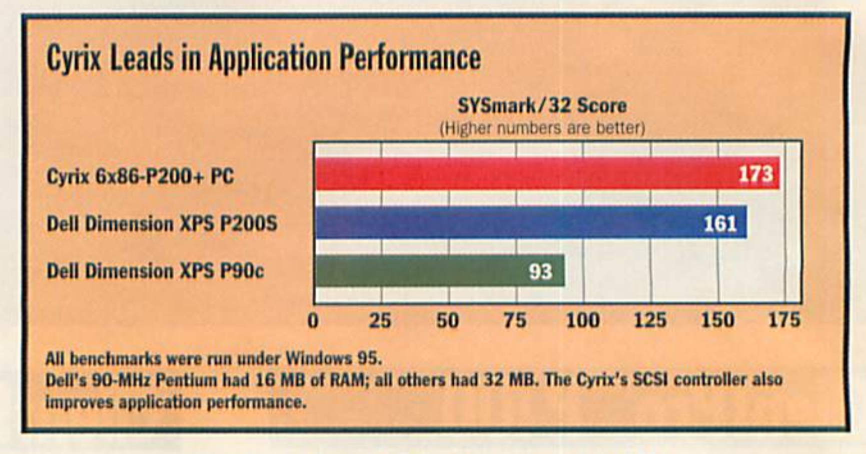
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Cyrix 6x86 Matches Pentium

Application benchmarks show that Cyrix's new 6x86 processor deserves its "200" label.

Although the 6x86-P200+ runs at just 150 MHz, application benchmarks indicate that Cyrix's newest processor lives up to its name, delivering the same or better performance than a 200-MHz Pentium. Although results of the CPU/FPU BYTEmark test indicate that the 6x86 has poor floating-point performance (a score of 0.43, compared to 1.0 for a 90-MHz Dell Pentium system), this won't hurt the performance of most Windows 95 business applications.

Results from running the new SYSmark/32 applications benchmark on Win 95 put a 6x86 PC computer from Cyrix slightly ahead of a Dell Dimension XPS P200S with a 200-MHz Pentium (see the chart at right). The SYSmark/32 benchmark suite, from Business Applications Performance Corp. (BAPCo), exercises popular word processing (Microsoft Word 7.0 and Lotus WordPro 96), spreadsheet (Microsoft Excel 7.0), database (Paradox 7.0), desktop graphics (CorelDraw 6.0), desktop-presentation (Microsoft Powerpoint 7.0 and Lotus Freelance 96), and desktop publishing (Adobe Pagemaker 6.0) applications.



The Cyrix P200+ PC edges the 200-MHz Pentium Dell XPS.

Although we compared similarly configured systems (both had 32 MB of RAM, a Matrox MGA Millenium graphics adapter, and a SCSI hard drive), differences between the Cyrix and Dell exist. The Cyrix system that we tested (which costs about $1500) was equipped with a 4-GB SCSI hard drive, 64 MB of RAM, a 75-MHz bus, extended data out (EDO) RAM, and a 256-KB synchronous pipeline burst cache, compared to the Dell system's 66-MHz bus, synchronous DRAM, and 512-KB pipeline burst cache.

To gauge the comparison of the two systems to a low-end PC, we also tested a 90-MHz Dell with 16 MB of RAM. The results show that power users shopping for a fast, affordable PC should investigate the latest from Cyrix ((800) 340-7501; http://www.cyrix.com). A 6x86-P200+ PC with a 256-KB cache, 16 MB of EDO RAM, Matrox MGA millenium video, 2 MB of Window RAM (WRAM), a 15-inch monitor, a keyboard, an eight-speed CD-ROM drive, a 2.5-GB Enhanced IDE (EIDE) hard drive, a floppy drive, a sound card, and speakers costs $2299.

–Dave Andrews

geek mystique

We know that movies with great special effects involving aliens from outer space require their audiences to suspend their disbelief to at least some degree. Nevertheless, we couldn't help but wonder about a few of the details in the hit movie Independence Day. What programming language did David, Jeff Goldblum 's character, use to write his computer virus that disabled the aliens' force field? Or was it a macro virus similar to one that hit BYTE editors at a recent trade show? What OS were the aliens using; was it Copland (Goldblum's character used a PowerBook)? Should more programmers start drinking hard liquor and throwing themselves on the floor to find solutions to difficult problems? And with all the resources they had at their disposal, couldn't the aliens afford an intergalactic version of an antivirus program?

Revenge of the nerds, part 73: Two software whizzes made the most recent Forbes magazine list of the top billionaires in the world. Tops on the list is Microsoft's Bill Gates, whose estimated net worth rose to $18 billion, thanks to the company's rising stock. Also making the Top 10, in eighth place, was Microsoft cofounder Paul Allen, with an estimated net worth of $7.5 billion. However, four of the Top 10 billionaires' fortunes were due largely to real estate or property investments.

Data Analysis Goes Upscale

Vendors of multidimensional-database products, seeking to address the complaint that their products can't effectively manage databases larger than 10 GB, are improving their programs' abilities to deliver enterprise-level data analysis.

To provide acceptable performance for users with complex financial, time-series-analysis, and forecasting needs, a multidimensional DBMS (MDDBMS) uses specialized data structures to organize, navigate, and analyze data that's often imported from a larger relational database. Once imported, original source data is indexed and further aggregated (i.e., summarized) to maximize performance of the multidimensional-analysis application. The resulting calculated data can be tens or hundreds of times greater in size than the input data.

The specialized-structure approach lets MDDBMSes perform complex analyses that would be unwieldy or impossible to express in the SQL used in relational databases. However, this approach left MDDBMS vendors open to the criticism that their products couldn't efficiently handle the large data sets (about 10 GB or more) required in large-scale, enterprise-level applications. In addition to improving scalability (see the table below), vendors are leveraging the Web to ease applications management and deployment.

By scaling up, multidimensional-database vendors, including Arbor Software, Pilot Software, Planning Sciences, and others, are challenging the assumption that large-scale on-line analytical-processing (OLAP) applications are the sole province of so-called relational OLAP products, such as Informix Software's Metacube and MicroStrategy's DSS Server. Relational OLAP databases operate more directly on a relational database, bypassing the need for a separate multidimensional data structure. But they aren't as good as multidimensional products for complex forecasting.

According to Howard Dresner, vice president of research at the Gartner Group consultancy (Stamford, CT), supporting larger data sets is one of several challenges that multidimensional-database vendors will have to meet. Others include the need to bolster third-party tool and management support and the inflexible nature of dimension-hierarchy definitions that makes it difficult for people who aren't database administrators to create new applications. Dresner advises companies embarking on an OLAP project to evaluate how much new training and additional skill sets a product will require, as well as to determine how well a vendor's long-term strategy meshes with their own. **–D. A.**

OLAP TOOLS TACKLE BIGGER TASKS

Company/Product	Highlights
Planning Sciences' Gentia 3.0 ((508) 898-9510; fax (508) 898-9511; http://www.gentia.com)	Now manages "up to 16 TB" per database; incremental data refreshes; centralized metadata layer for easier management.
Oracle/Express 6.0 ((415) 506-7000; http://www.oracle.com/)	New version offers 64-bit addressing and better multithreaded support for SMP systems.
Arbor Software/Essbase 4.0 ((408) 727-5800; fax (408) 727-7140; http://www.arborsoft.com)	New Intelligent Recalculation delivers faster data updates; now manages "multi-hundred-GB databases"; new query processor delivers faster analytical calculations and reduces network traffic.
Kenan Technology/AcuMate 1.3 ((617) 225-2200; fax (617) 225-2220; http://www.kenan.com)	Scalable multicube architecture; incremental data loads; new graphical development environment.
TM1 Software/TM1 ((908) 755-9880; fax (908) 755-9230; http://www.tm1.com)	Consolidates in real time for compact data cubes; multicube architecture reduces data footprint; version 6 offers faster calculations; more elements per dimension.
Pilot Software/Lightship Server ((617) 374-9400; fax (617) 374-1110; http://www.pilotsw.com)	Support for large member sets; intelligent precalculation and on-the-fly consolidation improve performance and reduce data storage.
Information Builders/Focus Fusion ((212) 736-4433; fax (212) 268-7470; http://www.ibi.com)	Incremental updates; optimized query performance; parallel-processing support.

yeah, but...

Because they operate more directly on relational databases without requiring a separate multidimensional database for on-line analytical processing (OLAP), relational OLAP (ROLAP) products, such as Informix Software's Metacube, can manage much larger data volumes for applications. By acting directly on relational data, ROLAP products eliminate the data duplication that's required with multidimensional products.

Yeah, but ROLAP products often need to store precomputed results, or summary tables, to achieve acceptable performance. These summary tables also duplicate data.

Many analysis applications involve simple sales- and production-analysis applications that are easily handled by ROLAP tools, which employ the SQL programming language to retrieve the needed data.

Yeah, but for complex applications, such as forecasting, what-if analysis, and ratio comparisons, a multidimensional database is a better solution.

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SSA Products Deliver Better Storage

Next-generation disk-storage systems based on the Serial Storage Architecture (SSA) technology have arrived for desktop computer systems, offering numerous advantages over today's UltraSCSI solutions. Promising throughput up to 80 MBps per adapter (and 160 MBps by the end of the year), storage capacities of a terabyte or more, and other advantages over UltraSCSI, SSA targets digital-video editing, prepress applications, and other high-volume, bandwidth-limited applications.

SSA, a serial-connection technology, abandons the wide parallel cables used by SCSI in favor of a simple four-wire serial connection. SSA minimizes the number of high-speed I/O connections required for a device; this reduces power consumption and increases reliability, critical issues for large disk subsystems. SSA also provides flexible cabling options, supporting up to 127 devices on a loop in which the nodes can be 65 feet apart using copper, and about 2500 feet apart using fiber.

SSA systems are typically configured in a loop topology. Data travels bidirectionally around the loop in bucket-brigade fashion. Packets of data hop from point to point as they travel around the loop, eliminating the need for system-wide bus arbitration and contributing to SSA's high potential bandwidth. Each loop supports more than one host, and each host can handle up to 80 MBps on the same loop simultaneously.

In theory, a single-loop SSA array supports two ports with two directions at 20 MBps, or a cumulative bandwidth of 80 MBps per adapter. But this bandwidth assumes an optimum combination of reads and writes that takes full advantage of SSA's bidirectional nature. A four-port controller connected to two array loops should support a peak bandwidth of 160 MBps. The SSA Standard Committee's new specification increases the link speed to 40 MBps, which doubles the loop bandwidth for future SSA products.

Fibre Channel–Arbitrated Loop (FC-AL) is also emerging as an alternative high-speed storage interface. Fibre Channel, conceived for use as a fast, reliable backbone for linking channel-based systems, was adapted into FC-AL for use as a storage back end. FC-AL is a 100-MBps single-direction loop technology. Like SCSI, FC-AL is an arbitrated bus, and data transfer proceeds from only one node on the loop at a time.

SSA delivers flexible connections and a high device count, but much of its performance is still just a promise. IBM, for example, says that the throughput of its current SSA controller performing a combination of read/write operations is limited by its PCI interface chip. IBM says its adapter currently delivers between 43 and 70 MBps on a two-loop system (one adapter card with four ports).

"The bandwidth of 20-MB SSA is well balanced with the chip set we've currently got, but we do recognize that we've got to go beyond that with 40-MB SSA," says Alistair Symon, project-control manager at IBM. "Future controllers will replace the PCI interface with an in-house design that removes the bottleneck."

A similar single-loop controller from Pathlight uses the same PCI interface chip, from PLX Technology. In tests that were performed at BYTE, a single StreamLine-PCI SSA adapter card ($995) delivered a throughput of approximately 40 MBps. In a random large-block read/write operation, the adapter supported 41 MBps in an array of 16 drives (theoretically, that number should be 80 MBps). In a sequential large-block read operation with one card, we observed approximately 39-MBps throughput.

Those numbers are slightly better than the fastest UltraSCSI performance that BYTE saw in a recent review (see "UltraSCSI Doubles Speed" August BYTE), but thanks to SSA's ability to host multiple adapters on a loop, SSA can deliver even better aggregate performance. For example, with two computers on the same loop, each with a Pathlight adapter card, BYTE measured an aggregate throughput of 71 MBps.

Pathlight officials contend that the throughput is currently limited by a combination of the card's PCI interface chip, the current implementation of PCI, and the speed of system memory. Although IBM and Pathlight provide different explanations for SSA's current performance, both companies are promising even better throughput in their future products.

WHERE TO FIND

Pathlight	IBM
(800) 334-4812	(800) 426-3333
fax: (607) 266-4010	http://www.chips.ibm.com/products/ss-ip/
http://www.pathlight.com	

As with most cutting-edge technologies, it will take time before applications and OSes are updated to take full advantage of SSA's new capabilities. For example, SSA supports the connection of multiple computer systems to the same loop. But of the many OSes that SSA vendors currently support (e.g., Windows 95 and NT, NetWare, Mac OS, SCO Unix, and NextStep), only AIX currently supports shared access to the same data by those systems.

Despite its interface problems and currently incomplete OS support, at present SSA is poised to greatly extend the limit of what's possible for desktop storage subsystems. **–Robert L. Hummel**

future watch

A consortium of radar-detector manufacturers and the Georgia Institute of Technology have teamed up to create a more helpful—and more useful—radar detector. Next-generation units will double as safety-warning devices, giving drivers messages such as "Road Work Ahead" or "High Winds Ahead."

The receiver's on-board microprocessor will hold 64 fixed-text messages, which can be displayed on an LCD. A transmitter placed near a traffic hazard or mounted on police and emergency vehicles sets off the receiver and alerts drivers to impending danger. These receivers also function as radar detectors.

No transmitters are currently operating in the field, but the Safety Warning Foundation is working with state departments of transportation to ensure that the transmitters are deployed, which will probably take several years. Also planned are message-only receivers for drivers who are not allowed to carry radar detectors or for use where detectors are illegal. **–Jason K. Krause**

Compaq Notebook Named Best of PC Expo

Compaq Computer's Armada 4100, a modular notebook PC that can morph from a thin, 5-pound notebook up to a full multimedia system, won BYTE's Best of Show and Best Portable awards at PC Expo. Notebook finalists were Texas Instruments' high-end, Pentium-based TravelMate 6030 and Toshiba's Portégé 650CT, which fits an 11.3-inch active-matrix screen and other features into a 4.8-pound package.

Best Technology winner, Sony Electronics' AIT (Advanced Intelligent Tape), as featured in the company's SDX tape drives, features a 16-Kb memory chip in the cartridge for better performance and reliability.

Best New Application, Corel's WordPerfect Suite 7 for Windows 95, won in part due to its Internet connectivity. The three finalists were IBM's VoiceType Dictation 3.0 for Win 95, Dragon Systems' DragonDictate 2.5 for Windows, and Macromedia's xRes 2.0 photo-image-editing program for Windows.

Sony Electronics won Best Multimedia Hardware for its Digital Video Still-Image PC Capture Board, the DVBK-1000, which works with Sony's digital Handycam. By eliminating the A/D-conversion process, the DVBK-1000 enables you to capture higher-quality images. Finalists were Connectix's Color QuickCam digital video camera and Sigma Designs' RealMagic Ultra, a $399 MPEG playback board.

Multimedia Software winner was Fractal Design's Expression, a natural-media, vector-based drawing program with support for animation. Finalists were DeLorme's AAA Map'nGo 2.0, a travel and mapping program, and Corel Click and Create, a $695 point-and-click authoring tool.

Best Connectivity Hardware winner was Apex Data's ClipperCom World PC Card fax modem, which will work in 31 countries. Finalists were Zyxel's $1095 Prestige 2864I ISDN LAN router, bridge, terminal adapter, and analog modem; and Adtran's $469 Express XRT ISDN modem. Best Connectivity Software went to White Pine Software's Enhanced CU-SeeMe multiple-person videoconferencing and application-sharing program. Finalists were Brooktrout's Show N Tel telephony applications development kit and Castelle's FaxPress Mac Software Option.

Stratus's fault-tolerant, Pentium Pro–based RADIO (Reliable Architecture for

Best of PC Expo

Notebook: Compaq, (800) 345-1518 or http://www.compaq.com; Texas Instruments, (800) 848-3927 or http://www.ti.com; Toshiba, (800) 999-4273 or http://computers.toshiba.com.

Technology: Sony's Tape Streamer Products Division, (800) 352-7669 or http://www.sel.sony.com.

Application: Corel, (800) 772-6735 or http://www.corel.com; IBM, (800) 825-5263 or http://www.ibm.com/products; Dragon Systems, (800) 825-5897 or http://www.dragonsys.com; Macromedia, (415) 252-2000 or http://www.macromedia.com.

Multimedia Hardware: Sony Electronics, (800) 222-7669 or http://www.sony.com; Connectix, (800) 950-5880 or http://www.connectix.com; Sigma Designs, (510) 770-0100 or http://www.realmagic.com.

Multimedia Software: Fractal Design, (800) 297-2665 or http://www.fractal.com; DeLorme, (207) 865-4171 or http://www.delorme.com; Corel, (613) 728-0826 or http://www.corel.com.

Connectivity Hardware: Apex Data, (510) 623-1231 or apexdata@smartm.com; Zyxel, (714) 693-0808 or http://www.zyxel.com; Adtran, (205) 971-8000 or http://www.adtran.com.

Connectivity Software: White Pine Software, (603) 886-9050 or http://www.cu-seeme.com; Brooktrout Technology, (617) 449-4100 or http://www.brooktrout.com; Castelle, (408) 496-0474 or http://www.castelle.com.

System: Stratus Computer, (508) 460-2000 or http://www.stratus.com; DeskStation Technology, (800) 793-3375 or http://www.dti.com; Sony, (800) 222-7669 or http://www.sony.com.

Utility: Cheyenne Software, (800) 243-9462 or http://www.cheyenne.com; Symantec, (800) 441-7234 or http://www.symantec.com; Adobe Systems, (800) 682-3623 or http://www.adobe.com.

Printer: NEC, (800) 632-4650 or http://www.nec.com; IBM, (303) 924-4675 or http://www.ibm.com; Mannesmann Tally, (800) 843-1347 or http://www.tally.com.

Peripheral: ViewSonic, (909) 444-8800 or http://www.viewsonic.com; InFocus, (503) 685-8888 or http://www.infs.com; Epson, (310) 782-0770 or http://www.epson.com.

Internet Product: Haht Software, (800) 996-3222 or http://www.haht.com; Maximum Information, (415) 981-5800 or http://www.maxinfo.com; Folio, (800) 543-6546 or http://www.folio.com.

Development Software: Attachmate, (800) 426-6283 or http://www.attachmate.com; Blue Sky Software, (619) 459-6365 or http://www.blue-sky.com; StarBase, (888) 782-7700 or http://www.starbasecorp.com.

Bug of the Month

U.S. Robotics Fixes Modem Meltdown

Usually when a product is said to be "hot" in the industry, it usually means that it's popular and a big seller. But not always. Users of early versions of U.S. Robotics' Courier 28.8 PC Card modem found them a little too hot. Some of the modems were overheating to the point of failure, or worse, causing notebooks to stop working altogether.

U.S. Robotics says it has fixed the problem with new Couriers that began shipping in volume in June. U.S. Robotics didn't issue a total recall of the modem, but it has replaced units for customers when necessary. The company says notebooks that did a poor job of heat dissipation were more prone to the problem than those with decent ventilation.

Send yours to edejesus@bix.com!

Distributed Input/Output) PC Cluster server won Best System. Finalists were DeskStation Technology's 500-MHz Alpha CPU–based Raptor ReFlex and Sony's PC VAIO (Video Audio Integrated Operation).

Cheyenne Software's ARCserve 6 backup program for NT, with support for a wide range of OS clients, won Best Utility. The Norton Your Eyes Only file-encryption utility, from Symantec, and Adobe Systems' $49.95 ATM Deluxe 4.0 font manager were finalists.

The NEC Superscript 860, an 8-ppm laser printer that ships with Adobe PrintGear, won Best Printer. Finalists were IBM's new laser printers (they range from the 12-ppm monochrome Network Printer 12 to the IBM Network Color Printer) and Mannesmann Tally's T7070 Color Ink Jet. Best Peripheral winner was ViewSonic's P815 21-inch monitor. The finalists were InFocus's SuperVGA LitePro 620 Projector and Epson's small-footprint PhotoPlus Color Scanner.

Best Internet Product winner, Haht Software's HahtSite, enables you to create and manage your own Web applications. Maximum Information's Intrachange Web Management software and Folio's Web Retriever 2.0 were both finalists.

The EHPS (Emissary Host Publishing System), Attachmate's Web-deployment extension for its Extra Developer Series, won Best Development Software. Finalists were Blue Sky Software's Visual SQL development tool for Visual C++ and StarBase's StarTeam Server 2.0, which is a software server that engenders distributed development among teams of programmers.

Survey

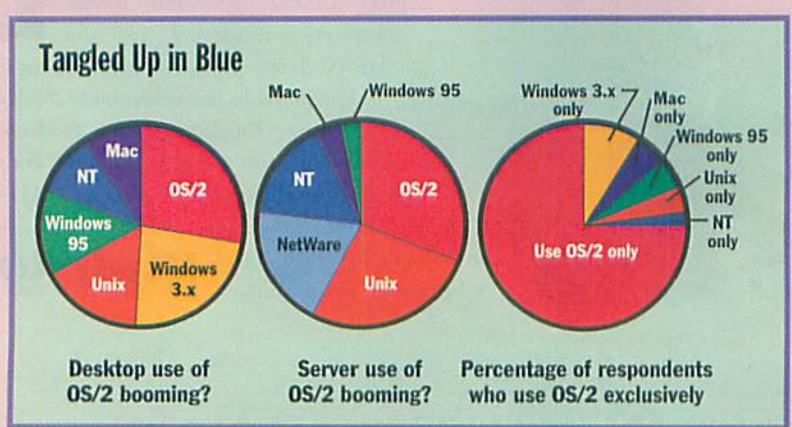
BYTE Learns a Lesson in Web Surveys

What a difference a medium makes. Over the past several years at trade shows, such as Comdex, BYTE has polled attendees who visited the BYTE booth on current and future OSes and processor use. The surveys, which we occasionally published in BYTE, typically sampled 1000 or more attendees who happened to visit the BYTE booth at a trade show.

We wanted to do that on the Web to get even more respondents, but it didn't work as we'd hoped. Why? Because at Comdex, a busy trade show where people usually have too much work to do to try to stuff a ballot box, the poll surveyed a more-or-less random sample of the computing population. But on the Internet, one posting in an Internet advocacy newsgroup can quickly rally an entire population segment to vote in a Web survey. And that's what happened to us.

The information below is a perfect example of that. You might think that AIX and OS/2 are surprisingly popular if you were to take the information below at face value. The problem is that our data was biased by OS/2 and AIX supporters who wanted to ensure their favorites did well: Survey responses are 12 times more likely to come from ibm.com than are typical BYTE Site visits.

Lesson learned: The Web doesn't change fundamental survey maxims; you can't let the studied population select itself. And, to the individual who voted over 80 times in the survey for Unix (your IP address is 198.182.4.224): Get a life.



Codetalk

by Rick Grehan

Visual RAD Gets Very Small

MP-Driveway plays in the realm populated by "deeply embedded" applications. Such applications are typically constructed around a microcontroller with internal ROM and RAM, plus peripheral devices: lights, switches, and valves, for example. The software developer sees a microprocessor whose finite set of on-chip peripheral controllers must be efficiently deployed.

Launch MP-Driveway, and your project is displayed in hierarchical tree form. This inverted "project tree" is rooted in the CPU, with branches consisting of the on-chip peripherals. For example, when you choose a project built on the PIC16C64, you see an icon representing that processor as the root, and beneath are labeled icons of the 16C64's peripheral deivices: five I/O ports, capture/compare and PWM registers, interrupts, and other elements.

Building an application amounts to clicking on a peripheral and selecting associated routines for controlling that device from MP-Driveway's built-in library. If you want to use PORTB as an input port, you click on the PORTB icon, and dialog boxes lead you to the appropriate routine. Once you've assembled all the control routines that your application needs, simply click on the Generate menu selection, and MP-Driveway emits C source code.

MP-Driveway is the result of a collaboration between Aisys (which sells Driveway for other chip families) and Microchip Technology. MP-Driveway sells for $495, and you will need the Byte Craft MP-C compiler ($795) to create an executable. (Microchip will have its own compiler available for $695 by the time you read this.) If your applications find you working frequently with Microchip's PIC family of processors, this is one product you must investigate.

Microchip Technology,
(602) 786-7299;
http://www.microchip.com.
Byte Craft, Ltd., (519) 888-6911;
info@bytecraft.com.
Aisys, (800) 397-7922;
http://www.aisys-usa.com.

"Can we do

business on

the Internet

without

getting

bamboozled

by some

wily

hacker?"

COMMERCE

Talk to ten Internet experts and you'll get ten different opinions about the future of business on the Net. But the bottom line is this: Internet commerce will grow only as fast as confidence in the security of the Net grows.

Fortunately, our confidence has grown pretty fast over the last couple of years. IBM SecureWay™ includes a variety of services and products that, over time, will make exchanges across the Internet even more secure than nonelectronic transactions.

For example, the Secure Electronic Transactions protocol, developed using iKP multiparty payment protocol from IBM Research, allows buyers, sellers and credit card companies to be joined in a single Internet transaction that is secure, confidential and verifiable.

Our Cryptolopes™ technology promises to revolutionize online publishing by providing a mechanism for controlling distribution of copyrighted materials.

And, of course, IBM is at the forefront of network security with powerful firewall, encryption and access control technology, not to mention one of the largest private secure business networks in the world – the IBM Global Network.

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New Macs Feature Latest PowerPCs

A new round of Macintoshes featuring the latest high-performance PowerPC processors was scheduled to arrive in early August. New systems from Apple and Power Computing will range from dual, 180-MHz 604e systems to more-affordable 603e desktop systems. Here are the highlights.

Power Computing ((512) 388-6868; fax (512) 388-6798; http://www.powercc.com)

- **PowerTower Pro 225:** The company's high-end system features a 225-MHz PowerPC 604e; 16 MB of RAM (expandable to 1 GB); a 2-GB, AV-capable hard drive; an eight-speed CD-ROM drive; 1 MB of Level 2 cache; six PCI expansion slots; built-in Ethernet (AAUI and 10BaseT); and other features, for $4995. For a 200-MHz PowerPC 604e in the above configuration, subtract $500. Other less expensive configurations with 180-MHz 604e and other processors are available, as are AV configurations with extras such as an internal Iomega Jaz drive.
- **PowerTower 200e:** With a 200-MHz 604e, 16 MB of RAM, a 2-GB AV-capable hard drive, 2 MB of on-board video memory, a quad-speed CD-ROM drive, and a 512-KB Level 2 cache, $3595. With a 180-MHz 604e, subtract $300.

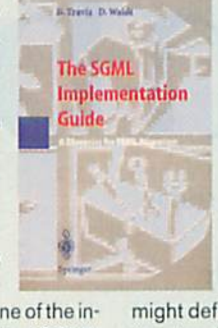
Apple Computer ((800) 767-2775; http://www.apple.com)

- Apple's first dual-processor system, the 9500/180MP, will feature dual 180-MHz 604e processors and an eight-speed CD-ROM drive. The new 9500/200 will be based on a 200-MHz 604e, which scored a 5.1 and a 4.3 in the BYTEmark integer and FPU tests (compared to a 4.4 and a 3.6 in a 180-MHz PowerPC 604–based system). Prices were unavailable at press time.
- The new Performa 6400 features a 180- or 200-MHz 603e processor with an optional 256-KB Level 2 cache, 16 MB of RAM, a 1.6- to 2.4-GB IDE hard drive, two PCI slots, and an optional Apple Video System.

Book Reviews

Serious Internet Tools

Although the Hypertext Markup Language (HTML) is a powerful tool, a large number of users have discovered that its limited set of tags and tools is not enough for environments that demand widespread reuse of complex information. One answer is Standard Generalized Markup Language (SGML), the data standard on which HTML is based. Four new books that untangle SGML's complexities take strikingly different approaches.



Experienced SGML analysts have criticized the first book, *Readme.1st*, as being too simple. The book targets SGML beginners, but its technical pedigree is impeccable: It's the first of a series of SGML books edited by Dr. Charles F. Goldfarb, one of the inventors of SGML. Written by a trio of SGML consultants, the book targets writers and editors who want to be able to use SGML's powerful tools but don't have computer-science degrees.

ABCD...SGML is the book to buy when your primary goal is to explain SGML to managers or customers. Liora Alschuler's book has an extensive list of case studies and sketches showing how organizations as diverse as Microsoft, Standard & Poor's, and a university press use SGML—and the benefits reaped from doing so. In addition, the author explicitly devotes an entire chapter to the question "Who Needs It: Making the Case for SGML," an important subject that the other books take for granted or discuss only in passing.



If you're currently responsible for creating an SGML application, *The SGML Implementation Guide* may be your first choice. Its authors have nearly two decades of experience implementing SGML and offer a good overview of SGML projects, from the early steps of information analysis to the final stages of version control. They also give an overview of the language and discuss SGML's place in information management.

Developing SGML DTDs focuses on the fundamental SGML process of building DTDs (Document Type Definitions), which create the structure that gives SGML both its power and its complexity. The DTD for HTML, for example, uses about eight basic tags, while a DTD for a complex SGML application might define 200 tags. This book explains the step-by-step process that's required to produce the foundation of an SGML application.

The SGML Implementation Guide and *Developing SGML DTDs* are complementary. *The SGML Implementation Guide* has a chapter on writing DTDs and devotes much of its space to the overall task of managing an SGML project. Topics include planning, conversion, and work-flow management. *Developing SGML DTDs* has a chapter on managing SGML projects but gives most of its attention to the mechanics of writing a useful DTD. The book uses a cookbook-and-recipes metaphor to provide examples of how to model an information set and create a DTD to reflect that model. **—Bart Preecs** *works as a project manager for SiteWerks, a Web development company in Seattle. You can contact him at bpreecs@sitewerks.com.*

Readme.1st: SGML for Writers and Editors
by Ronald C. Turner, Timothy A. Douglass, and Audrey J. Turner;
Prentice-Hall, 1995; 241 pages (includes index and floppy disk);
ISBN 0-13-432717-9; $45.

ABCD...SGML: A User's Guide to Structured Documentation
by Liora Alschuler; International Thomson Computer Press, 1995;
414 pages (includes index and floppy disk); ISBN 1-850-32197-3; $39.95.

The SGML Implementation Guide: A Blueprint for SGML Migration
by Brian E. Travis and Dale C. Waldt;
Springer-Verlag, 1995;
ISBN 3-540-57730-0; $49.50.

Developing SGML DTDs: From Text to Model to Markup
by Eve Maler and Jeanne El Andaloussi;
Prentice-Hall, 1995;
ISBN 0-13-309881-8; $45.

Japanese PCs, Round Two

They're back. Early in the PC revolution, Japanese electronics giants, such as Fujitsu, Hitachi, NEC, Sony, Toshiba, and others, appeared ready to dominate the U.S. computer market. But it didn't work out that way. Eventually, all but NEC and Toshiba (in notebooks only) faded from the scene. Now a new wave of PCs and innovative products from Japan-based companies has arrived.

Why the change? One reason is the standardization around the Intel processor and Windows 95. This lets Japanese companies leverage their strengths in manufacturing and distribution with competitive products. In contrast, the first time out, many of these firms tried to innovate with each new product, an expensive and risky strategy.

The first machine in this new wave is the Sony PC, a high-end small office/home office (SOHO) product that was a finalist in BYTE's PC Expo awards. The Sony PC includes a 200-MHz Pentium processor, 32 MB of RAM, first-rate audio and video, and a forward-thinking design.

In September, Toshiba will introduce its first PCs targeted at the home market. A line of business PCs from Toshiba is slated for 1997 arrival. Like the Sony PC, Toshiba's home PCs will have strong audio and video capabilities, plus support for telephony, digital videodisc (DVD), and videoconferencing. Hitachi and Fujitsu are also making serious forays into the notebook PC market.

Will this second attempt by Japanese PC makers succeed? Part of their success will depend on how well they can work with VARs, at least in the business PC market. Toshiba, which already has a strong notebook presence in the channel, appears to have an early advantage in this area. Sony seems guaranteed to obtain shelf space, thanks to its strong retail presence and brand name. Other vendors say they have big marketing commitments and will listen closely to customers before releasing products geared to the U.S. market.

All of this should mean good news for end users. It will bring a wealth of new products that are appealing, innovative, and attractively priced. **–Jon Pepper**

Datapro Report

CORBA, Java, and the Web

Vendors of object development products are using the Web as a transport and communications mechanism for distributed objects and as a front end (via Java-based applets and browsers) for object applications. This comes as an outgrowth of the Object Management Group's (OMG) Common Object Request Broker Architecture (CORBA) version 2.0, which provides a vehicle for communications between object request brokers (ORBs) developed by different vendors and between objects whose transactions the ORBs manage.

The new vehicle, the General Inter-ORB Protocol (GIOP), specifies message formats and data representation across any transport protocol. A second specification, the Inter-ORB Implementation Protocol (IIOP), provides preconfigured interoperability for ORBs running over TCP/IP, thus allowing the Internet to act as a backbone ORB that's accessible to other ORBs. The products below are part of the first round of object applications to use Internet technology. Expect additional implementations as improved object and Web standards appear over the next year.

BlackWidow, from Visigenic ((415) 967-6169; http://www.visigenic.com)
The BlackWidow ORB creates client- and server-based object applications that Java-enabled browsers can access. It's well suited for distributed applications because it provides two-way access between Java applets and objects on remote systems.

With BlackWidow, developers can convert interface definition language (IDL) interfaces to Java on clients and servers, create Java applets, and provide bidirectional access between Java applets and objects arranged by other ORBs. Since BlackWidow clients can directly invoke these objects, developers avoid the tedium of creating Common Gateway Interface (CGI) scripts for every invocation on a server.

BlackWidow's development component, an automatic IDL-to-Java code generator, converts object interfaces into both client- and server-side Java code; developers create distributed Java applets by adding application logic. The run-time component manages object location, connection, and communication, and it can access any Java-compliant Web browser.

OrbixWeb, from Iona ((617) 679-0900; http://www.iona.com)
OrbixWeb is part of the Orbix family of CORBA-compliant ORBs. OrbixWeb lets Java applets on a host use distributed objects managed by any CORBA 2.0 ORB. Unlike BlackWidow, OrbixWeb provides client-side development only, and it requires a separate Orbix server.

OrbixWeb includes a mapping between Java and the IDL, which associates IDL basic, template, and constructed data types with the appropriate Java constructs. Each IDL interface provides two Java mappings: one to Java interfaces for inheritance purposes, and the other to Java classes for implementation. Although limited to the client, OrbixWeb can access a variety of technologies and platforms through other Orbix products.

Visual Wave/GemStone Internet Application Server, from GemStone and ParcPlace-Digitalk (GemStone, (503) 629-8383; http://www.gemstone.com)
Applications-server (and former object-database) vendor GemStone and Smalltalk provider PPD together offer a large-scale Internet applications server. The Visual Wave/GemStone Internet Application Server (IAS) can deploy transaction-based Smalltalk applications supporting thousands of concurrent users via TCP/IP. IAS provides a three-tiered architecture for Internet applications. PPD's VisualWave Server functions as the back-end Internet server; its Visual Wave development environment creates client front ends with hooks to popular browsers. The GemStone 4.1 object application forms the middle tier.

Visual Wave servers can be clustered, and the Visual Wave development environment automatically generates client-side HTML and CGI scripts directly from Smalltalk. It also lets developers update Web applications on the fly. GemStone IAS provides scalability, transaction integrity, and gateways to relational databases. It also lets developers use object technology instead of stored procedures for working with distributed databases.

–Deborah Hess *is a senior analyst at DataPro Information Services (Delran, NJ). For more information, call (800) 328-2776 or (609) 764-0100.*

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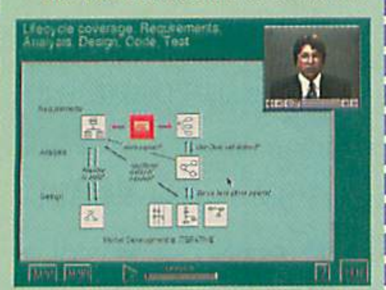
Circle 133 on Inquiry Card.

cd-rom review

A CASE for Better Multimedia

With more than 50 object-oriented code-design methods to choose from, program developers are, understandably, a divided lot. CASE tool provider Rational Software (Santa Clara, CA) recently created a stir by hiring the authors of three popular methods to collaborate on a new, unified method. The resulting CD-ROM, titled A Unified Object Modeling Approach, purports to detail the unification of these three approaches (James Rumbaugh's Object Modeling Technique [OMT], Grady Booch's Booch Method, and Ivar Jacobson's Use Cases Method). However, the final unified method specification had not been released at press time.

This two-CD set could be a valuable resource, but it falls short for several reasons—the most obvious being that it's painfully dull and lacks interactivity. The narrator delivers a stream of lectures from inside a QuickTime window. You can view several diagrams and tutorials, but these are confusing and incomplete.



A Unified Object Modeling Approach.

It's hard to get a complete picture of the unified approach from this CD; it doesn't provide details about how to actually create code. Author Doug Rosenberg promises an updated version once Rational Software releases its unified approach, but that makes me wonder why this CD-ROM is necessary. This is an important topic for developers; it's a shame it was not presented better. –J. K. K.

A Unified Object Modeling Approach
SIGS Books and Multimedia, 71 West 23rd St., New York, NY 10010, (800) 871-7447
http://www.sigs.com
$995

New Programs Take Better Dictation

Though not quite there yet, the latest speech-recognition programs are closer than ever to reaching the ultimate goal of speaker-independent, continuous dictation. The newest programs allow you to speak naturally when giving your PC commands such as "Open file," but they still require you to pause slightly between words during dictation. However, the length of that pause continues to decrease, and, as mentioned in "I'll Talk To You Soon" (March BYTE), vendors expect to reach that continuous-dictation holy grail in the next few years. Until then, the ever-increasing power of PC hardware, combined with more-sophisticated voice-recognition software, makes voice recognition a viable choice for many users.

"Most of these products are in their second or third generation," says William Meisel, head of TMA Associates (Encino, CA), a market-research firm covering speech technology. "The market is now mature, and many of the previous impediments have been removed."

For example, one major roadblock, the requirement of a dedicated card, has been eliminated now that these programs work with most major sound cards. Also, the major programs no longer require lengthy training sessions, although accuracy usually improves with an optional training session and continued use.

The three key players in the PC-based voice-recognition market—Dragon Systems, Kurzweil Applied Intelligence, and IBM—all have roughly equivalent capabilities, but with inevitable differences. For instance, IBM's new VoiceType 3.0 program, a subset of which will appear in the next version of OS/2, enables you to dictate a program and defer its correction to a later date—or even to someone else, such as an assistant. And the latest version of DragonDictate can read back any file or portion of a file that you designate.

Nevertheless, barriers prevent these current products from reaching mass acceptance. For example, hardware requirements are relatively hefty. Kurzweil and Dragon say that their products will run on a 486 but recommend a Pentium. And IBM requires at least a 90-MHz Pentium-based PC with a 256-KB L2 cache and 16 MB of RAM. Also, audio files created by IBM's delayed correction can quickly consume hard disk space.

These requirements, plus the elusiveness of continuous dictation, limit much of the potential market to specialized users, such as people who lack typing skills or who suffer from a repetitive-stress problem. Says Meisel: "People just aren't strongly motivated to use a microphone yet if they're comfortable with a PC and a keyboard." –J. P.

WIN 95 DICTATION HIGHLIGHTS

Company	Product	Highlights	Price
Dragon Systems, (800) 825-5897; http://www.dragonsys.com	DragonDictate 2.5 for Windows	New text-to-speech feature reads text back to you; voice macros for Netscape Navigator; 10,000- to 60,000-word, fully loaded, active vocabulary; continuous speech for commands; pop-up window aids on-the-fly correction; NT support; no training required.	Personal Edition (10,000-word active vocabulary), $395; Classic Edition (30,000 words), $695; Power Edition (60,000 words), $1695
IBM, (800) 825-5263; http://www.software.ibm.com/workgroup/voicetyp	IBM VoiceType 3.0 for Windows 95	Delayed and delegated correction let you edit a document later or send a copy of a file with your recorded voice to assist someone else in correcting; no training required; continuous speech for commands.	$699
Kurzweil Applied Intelligence, (800) 380-1234; http://www.kurz-ai.com	Kurzweil Voice Release 2.0	No voice training required; 30,000- to 60,000-word vocabulary; supports direct dictation within over 30 Windows applications.	$695

Blasts from the Past

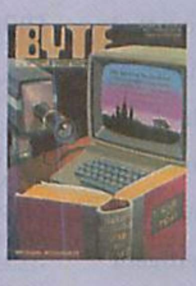

Years ago in BYTE

The Apple/IBM alliance made big news. But of the many proposed collaborations, including work on new multimedia standards (e.g., ScriptX) and the new object OS code-named Pink, only the PowerPC is now in the hands of a significant number of users. Meanwhile, Microsoft was working on Windows 3.1, the successor to Windows 3.0.


Years ago in BYTE

BYTE editors were excited about a beta version of a program that combined a data-flow programming model with an iconic language for scientists. The program was for scientists and engineers who didn't want to become computer whizzes in order to exploit the personal computer's capabilities. The program, called LabView, turned a regular Mac into a general-purpose laboratory tool.


Years ago in BYTE



We wrote about artificial intelligence, but most interesting in retrospect is the six pages that we devoted to a new computer, called the Alto, from the Xerox Palo Alto Research Center. It featured a striking graphics display, new Ethernet networking capability, and an input device known as a mouse. BYTE correctly predicted that the attributes of this Alto "research tool" would be used in the next generation of personal computers.

Knuth Comments on Code

Don Knuth, currently working on volume 4 of his Art of Computer Programming and on Selected Papers on Computer Science, comments on good programming practices.



BYTE: You were recently awarded a Kyoto Prize, Japan's esteemed private award for lifetime achievement, for your past contributions to computer science. Looking ahead, what are some of the critical issues facing programmers?

Knuth: Well, I'm not a very good prophet. My shtick is to promote the idea that humans, not computers, read programs. Today, humans can create programs that are faster, better, and more reliable using tools that are getting better all the time.

But 98 percent of the world's people are not computer programmers. I ask programmers to think of themselves as writers, teachers, expositors. When you are programming, the very act of trying to explain it to another human being forces you to be clearer. And then later on, you can maintain, modify, and port your programs to other platforms much more easily. Even if your only audience is yourself, everything gets better.

BYTE: Judging from the number of bugs that we see in commercial software, vendors seem to prioritize features over error-free code. Will new tools or new programming techniques result in more-stable software?

Knuth: There's no royal road, and you can't make any complex program totally fail-safe. You can test a program for a year, and then someone or something will create a condition that nobody ever anticipated, and then very subtle errors become very visible. The layers that y place on a program to make it fail-sa can themselves fail.

I certainly don't say that we shou avoid using techniques like redundan to increase the stability of critical pr grams or that we should write code a not worry about the consequences. Co puter programs are the most complic ed things that humans have ever create That's why I say this idea of expositi is the best way of coping with the co plexity. I use that method when I'm wr ing a program; I approach it as if I we writing a short story. It doesn't take any longer, because the time I spend organization is more than made up for time saved debugging.

BYTE: Do you think that progran are coming out too fast today for use to keep up?

Knuth: Steve Jobs once told me in 19 that he had a vision where every day would get a CD-ROM with 1000 bran new programs on it, and that althou each program would cost just $5, t number of potential users for each pr gram would be high enough that so ware developers would get a good retu on their work. He didn't think about ho we would all cope with 1000 progran a day, but I note that controlled grow failed on the other side of the Iron Cu tain. You need uncertainty to foster inn vation. A healthy degree of confusion c serve to keep people creative.

BYTE: In reviewing programming it has evolved over the past 10 years, you see anything that makes you d appointed—for example, in the obje computing realm?

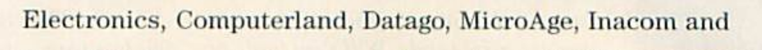
Knuth: They haven't yet built a re able way to reason about these progran that is, we still lack the mathematic proof to ensure that a program will wo With object-oriented programs, we ha much less of an understanding of h we would ever prove that they don't ha bugs. This is a huge gap. If people c understand OOP, they ought to be a to prove that the programs are corre

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00-387-3867. *Average U.S. street price for Pentium® processor-based HP Vectra 510 5/75 PC. Monitor not included. HP Vectra 500 PCs come with Microsoft Windows 95 preinstalled. and 166 MCx models, optional on all other models. [1]Other capacities available. [2]Standard on CD, MC and MCx models. [3]Multimedia models only. [4]On-site, second-day business service. dows are U.S. registered trademarks of Microsoft Corporation. Pentium and the Intel Inside logo are registered trademarks of Intel Corporation. ©1996 Hewlett-Packard Company PPG429

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Internet Explorer 3.0 makes a strong play for Web dominance. By Rex Baldazo

Microsoft Catches Up with Netscape

Web browsers have become the primary battlefield in the war for the heart and soul of Internet citizens. Microsoft's two previous Web browsers were OK, but they didn't demonstrate any interesting new technologies. However, the third attempt, Internet Explorer 3.0 (IE 3.0), changes all that, matching the market-dominating Netscape Navigator feature-for-feature while adding lots of strategic Microsoft technology.

Support for Java was not in the beta version we tested, but it is slated for beta 2, which should be available when you read this. The beta we tested offers some support for JavaScript, although it's not yet totally compatible with Netscape's implementation.

Also in IE 3.0 is VBScript, Microsoft's own scripting engine. A slimmed-down version of the Visual Basic language, VBScript is Microsoft's challenge to Sun's JavaScript. It should appeal to the legion of Web developers who already know Visual Basic, but currently only IE 3.0 supports it. To encourage widespread adoption, Microsoft is making the VBScript engine available to all takers.

One of IE 3.0's more intriguing new technologies is support for in-place activation, part of Microsoft's OLE/ActiveX Document technology. For example, it lets you click on a Hypertext Markup



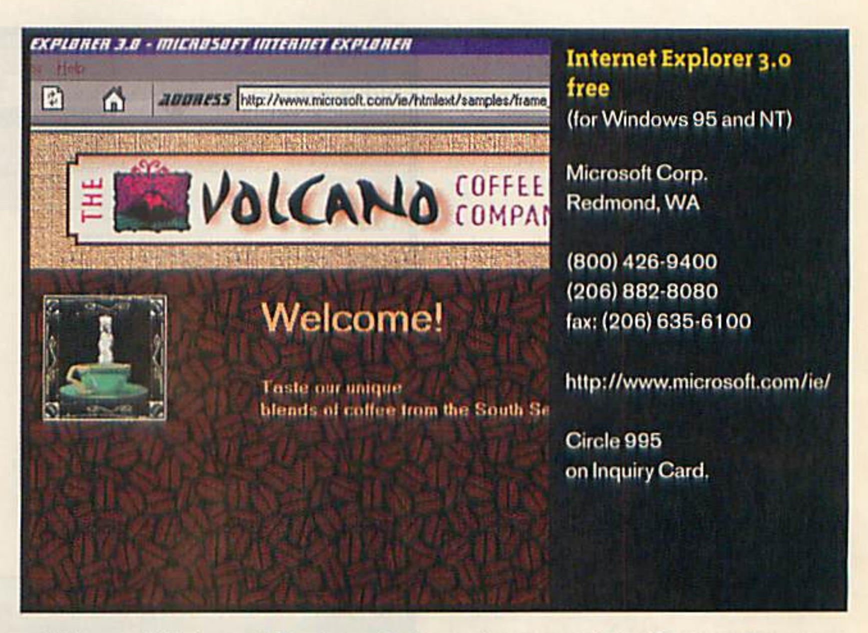
RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★

Language (HTML) link that points to a Word document, which opens up inside the browser window while Word is activated in place, adding its menus and toolbars to the browser window (assuming you have Word or the free Word Viewer installed on your computer).

The key is that this in-place stuff works with any application that supports the ActiveX Document technology, whether the file is on your local hard drive or coming across the Internet. This is a step toward a universal browser, where all content—from that on the Web to what's on your local hard drive—is viewed from the same browser.

More than anything else, it's ActiveX Controls that have the potential to make the greatest impact on the Web. They allow for powerful, interactive content similar to that of Java applets, but with the advantage of having mature development tools, such as Visual C++ 4.1.

The technology is still in its infancy, however, and some unanswered questions may delay widespread adoption. First among these is the fact that ActiveX Controls are intimately tied to OLE, which in turn is part of the Windows platform and does not yet work on Macintosh or Unix machines.



Internet Explorer 3.0
free
(for Windows 95 and NT)

Microsoft Corp.
Redmond, WA

(800) 426-9400
(206) 882-8080
fax: (206) 635-6100

http://www.microsoft.com/ie/

Circle 995
on Inquiry Card.

Microsoft Internet Explorer 3.0 sports a new interface and many important features, including borderless frames (shown).

The IE 3.0 user interface is also inconsistent, especially its drag-and-drop aspects. If you grab a text hyperlink in IE 3.0 and drag it to the Windows 95 desktop, it creates an Internet shortcut. If, on the other hand, you grab a hyperlink that's associated with a GIF or JPEG file, it drags the image rather than the shortcut. And, unlike the Win 95 desktop, the IE 3.0 interface has no right-mouse-button option for selecting whether to drag a shortcut or the image itself.

Overall, we were impressed with IE 3.0. There are still some rough edges, but the browser brings innovative new technology to the Internet. Whether this technology has any impact—and whether IE 3.0 can dent Navigator's huge market lead—remains to be seen. ■

Rex Baldazo is BYTE's technical editor in charge of software reviews. You can contact him at **rbaldazo@bix.com.**



ATM Deluxe 4.0 manages all your fonts—even TrueType—in versions for Windows 95, NT 4.0, and the Mac. By Russell Kay

Adobe's Finally the Managing Type

What's in a name? Though always called Adobe Type Manager, ATM never did much managing; it merely installed and rasterized on-screen the Type 1 (T1) fonts originally designed for PostScript devices. When Windows 3.0 introduced TrueType (TT) to the mass market, Adobe responded with a new ATM. The world was stuck with two formats.

Adobe and Microsoft are now working together on a new font format, OpenType, that will combine TT and T1 in a character-rich superset. But that's for the future. Right now, we've got the new ATM Deluxe 4.0, which handles both formats and introduces welcome new capabilities.

First, ATM knows about TT fonts. You install and activate them as if they were T1 fonts. Second, Adobe has finally put the manager into ATM. You define sets of fonts, using drag-and-drop editing, and activate only those sets or specific fonts you wish, thus considerably reducing the drain on system resources.

Other fonts are easily activated when you need them—even automatically.

TECH FOCUS

You Old Smoothie, You

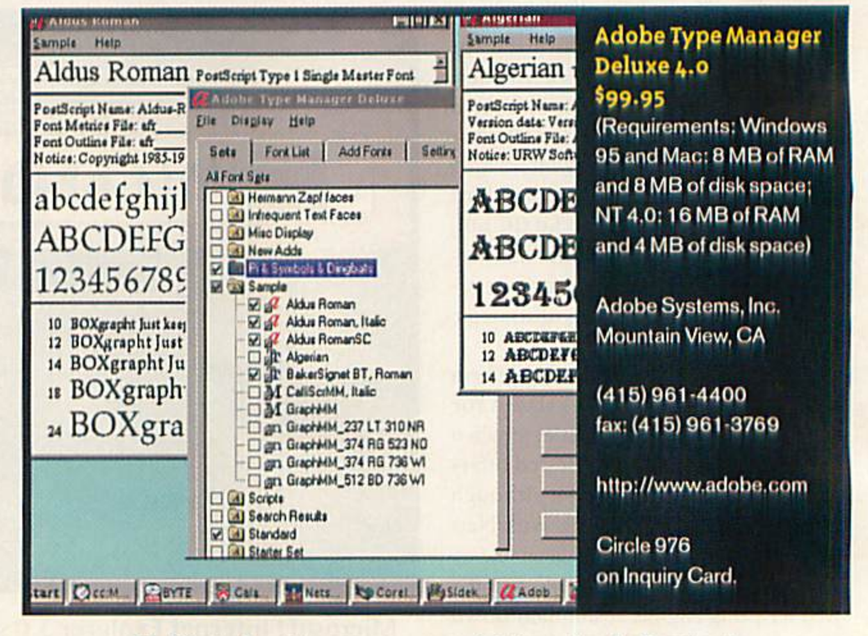
Display a digital font at a low resolution, and you get misshapen letters with stair-step edges. The neatest fix is called anti-aliasing, where selected edge pixels are rendered in shades of gray. Windows 95 Plus can do this for TrueType fonts if your video is able to support at least 64,000 colors. The new Adobe Type Manager Deluxe (for use with all platforms) performs font smoothing for Type 1 even on a 256-color display.

BOX

Unaided jaggies.

BOX

With ATM's antialiasing.



Multiple font types can coexist in a single font set, and you can activate them individually or as an entire set.

ATM font sets (but not the fonts themselves) are exportable to other systems and platforms, which will greatly simplify font management and graphics standardization in many large organizations.

You can easily see what a font looks like on-screen, print sample pages and one-line listings, and create new instances of multiple-master type fonts. And ATM now enables antialiasing for better-looking letters (see the Tech Focus box).

Finally, you get a complete database of Adobe font metrics. When a document calls for a font you don't have, ATM creates a substitute font (application permitting) and displays it in the exact letter widths, so line breaks won't change. The Windows NT version lacks this feature.

In BYTE's tests of the Windows 95 beta 8, ATM installed and ran easily, presenting no particular problems. It came up and loaded all the active fonts, incorporating them into a Starter set. When we had ATM search the system's hard drives, it quickly found all our additional fonts and added them to its master list.

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★
PERFORMANCE	★★★★

And it added new fonts considerably faster than ATM 3.0.2 could.

ATM Deluxe 4.0 debuts as a Win 95 CD, to be followed by a Mac/Power Mac version and, at year's end, the first-ever ATM for NT 4.0. NT users must now convert T1 fonts to TT for on-screen display.

ATM has really come into its own, and it's fast and friendly, to boot. ■

Russell Kay is a BYTE technical editor. You can reach him at **russellk@bix.com.**

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

Remember the

freedom you felt

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on the Internet?



PrintGear technology gives NEC's new laser printer a winning price/performance ratio. *By Robert L. Hummel*

Quality Printing, Fast and Cheap

Must a laser printer trade high performance for a low price? NEC wants to convince Windows users that the answer is "No." The company's new SuperScript 860 laser printer offers a speed of 8 pages per minute (ppm) and resolution of 600 dots per inch (dpi) for a street price of less than $500. As the first printer to use Adobe's new PrintGear architecture (see "How PrintGear Works" on page 59), the NEC SuperScript 860 can indeed outperform similarly priced lasers on most printing jobs.

The PrintGear architecture mandates that the entire page download into the printer's memory before processing starts. Despite this, NEC claims that the 860's standard 1 MB of memory can handle even complex documents when managed with Adobe's Memory Booster technology. A PrintGear innovation, Memory Booster combines data compression with graceful degradation to ensure that a page rarely, if ever, fails to print. A page too large for the installed RAM is compressed and reduced to 300-dpi resolution. You can install up to 4 MB of additional memory in an industry-standard SIMM slot.



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NEC's SuperScript 860 generally produces a smaller data stream and prints faster than more expensive models.

In our testing, the 860 generally produced both smaller data streams and faster return-to-application times than HP's LaserJet 5L. The biggest improvement came when printing pages that mix text and graphics; the 860 reduced both file size and time required to spool by approximately 50 percent.

To add small office/home office appeal, NEC has included such features as customizable watermarks and booklet, poster, and proof-sheet (N-up) printing options, all implemented through Windows driver software. The printer holds 200 sheets of paper (letter or legal size), as well as labels, transparencies, and as many as five envelopes.

The SuperScript 860's advanced features require Windows 3.x or Windows 95. NEC provides no Windows NT or OS/2 drivers. And while insisting they won't allow the 860 or its PrintGear incarnation to be orphaned, neither NEC nor Adobe has plans to develop drivers for these operating systems. Under DOS, NT, and OS/2, the 860's special features are unavailable; instead, it emulates a Hewlett-Packard LaserJet IIP.

In a Windows-only environment, however, the SuperScript 860's fast engine, high resolution, and versatile options make it a performance winner and an excellent value. ■

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★
PERFORMANCE	★★★★

TECH FOCUS

PrintGear Pros and Cons

Adobe's PrintGear architecture divides document interpretation between the computer's device driver software and the printer's PrintGear Imaging Processor chip. The driver represents the most common Windows print elements in the most compact way for a smaller data stream and a faster return to your application.

On the downside, a PrintGear printer's processor and its corresponding device driver form an integrated—and inseparable—system. Adobe has no plans to publish a single PrintGear standard and doesn't guarantee that different PrintGear printers can interpret each other's data streams.

Robert L. Hummel is an electrical engineer, programmer, and consultant. You can reach him at rhummel@monad.net.



Thanks to IBM's VoiceType technology, you can tell OS/2 Warp where you want to go. *By Barry Nance*

You Talk, Warp Listens

Call it the *Star Trek* dream—a computer that responds to spoken commands. OS/2 Warp 4.0, code-named Merlin, incorporates a voice-recognition technology called VoiceType that brings the dream a step closer to reality.

We evaluated the first public beta version of Warp 4, so we haven't run formal benchmarks yet. However, performance is crisp and responsive, though some advanced features—voice recognition in particular—require a speedy Pentium to work properly. Using a headset that will be included with every copy of Warp, plus the sound card in your PC, VoiceType supports both voice navigation and dictation. Navigation is the ability to tell your computer what to do—utter "Jump to Web Explorer" and OS/2 launches your Internet browser, for example.

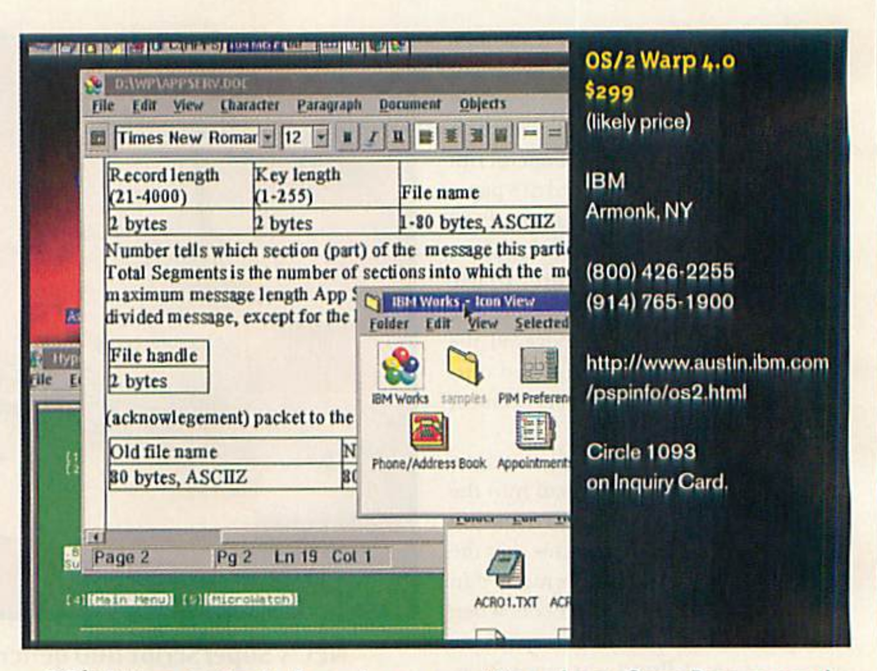
While Warp's voice navigation works with continuous speech, VoiceType's dictation feature requires discrete speech, in which you pause briefly between words to let the software identify individual words (see the Tech Focus).

Our test of VoiceType was pretty convincing, producing results as good as most people's typing. When we dictated the original draft of this article, recognition accuracy was about 95 percent.

TECH FOCUS

Voice Input

IBM's VoiceType relies on a variety of techniques as it takes your dictation. You must use discrete speech, which means you pause briefly between words. This allows VoiceType to identify individual words. As you dictate, VoiceType uses context analysis to decide what words you spoke. As a result, you might see the cursor flash back and alter a previous word as the program realizes it misidentified it.



OS/2 Warp 4.0 includes voice recognition, Java, OpenDoc, a word processor, network management, and thousands of device drivers.

And even with discrete speech the dictation took no more time than if we had typed the article instead.

OS/2 becomes the first desktop operating system to incorporate Sun Microsystems' Java technology (go to http://ncc.hursley.ibm.com/javainfo for details). As you surf the Web, or as you develop your own Internet-aware applications, you can use OS/2's Java interpreter or the supplied Java Development Kit to enhance your browsing.

Warp includes OpenDoc, the cross-platform component architecture that lets you create compound documents. The OS also comes with Open32, which emulates much of the Win32 API so programs written for Windows can be recompiled and run on Warp.

Warp 4 comes with a separate CD-ROM that has more than 2000 device drivers. IBM has added a new graphics device driver architecture to OS/2's 32-bit environment. The new driver model will soon support the dynamic loading and unloading of device drivers, IBM says.

OS/2's look and feel changes with version 4. We found Warp's new look a bit prettier than its previous countenance,

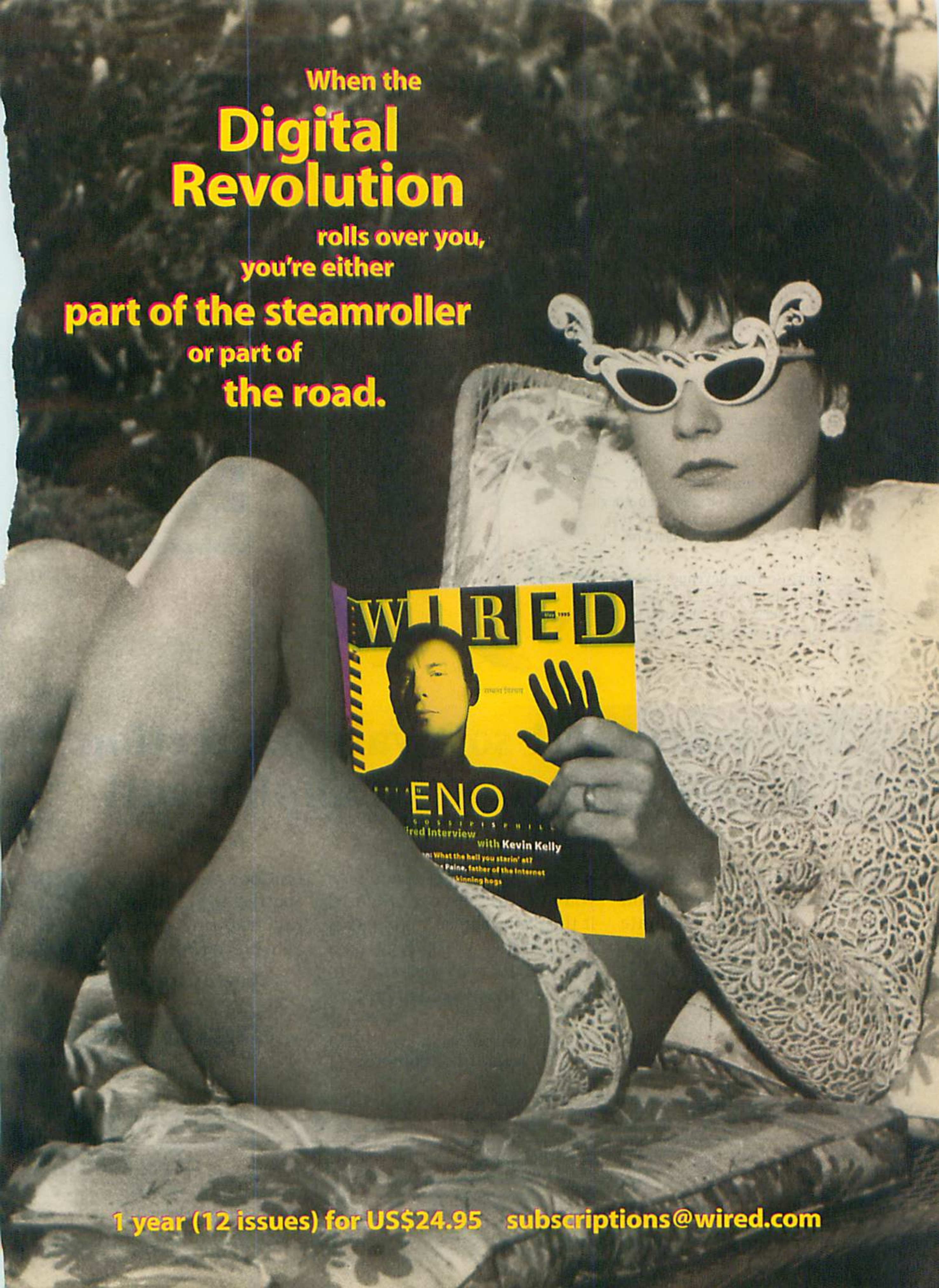


RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★★

but it doesn't make you more productive.

With Warp 4, you can use voice, keyboard, and mouse in any combination to navigate, control, enter data, and enter text. We think you may begin talking to your computer more and typing less. ■

Barry Nance, a BYTE contributing editor, is the author of Using OS/2 Warp *(Que, 1994). You can reach him at* **barryn@bix.com**.


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Sophisticated real-time products need an OS designed for real-time work. By Vik Sohal and Mitch Bunnell

A Real OS for Real Time

Developers of embedded and real-time products have often used homebrew kernels for their applications. The availability of powerful 32-bit CPUs and increasing user expectations are driving embedded software solutions to resemble full-fledged computer systems packaged as special-purpose products.

While embedded software gets more complex, shorter product cycles increase time-to-market pressures. The time issue has forced a strong emphasis on reusing software, rather than developing each embedded product from scratch.

Because of these trends, embedded product vendors are turning to a commercially available real-time operating system, LynxOS by Lynx Real-Time Systems. It provides a suitable operating environment for embedded applications in communications, networking, multimedia, and instrumentation. Its design emphasizes deterministic real-time performance, with desirable characteristics such as ROMability, modularity, and compact code required by such applications. With 90 percent of its code written in C, LynxOS is portable, and versions are available for the x86 family, the 680x0 family, the PowerPC line, and SPARC.

Design Goals

The LynxOS kernel design process addressed the following goals:

• **Predictable response under all load conditions** ensures that applications respond to external events in a predictable fashion, regardless of what else the system is handling. It requires consistent and prompt scheduling of time-critical tasks and low system overhead.

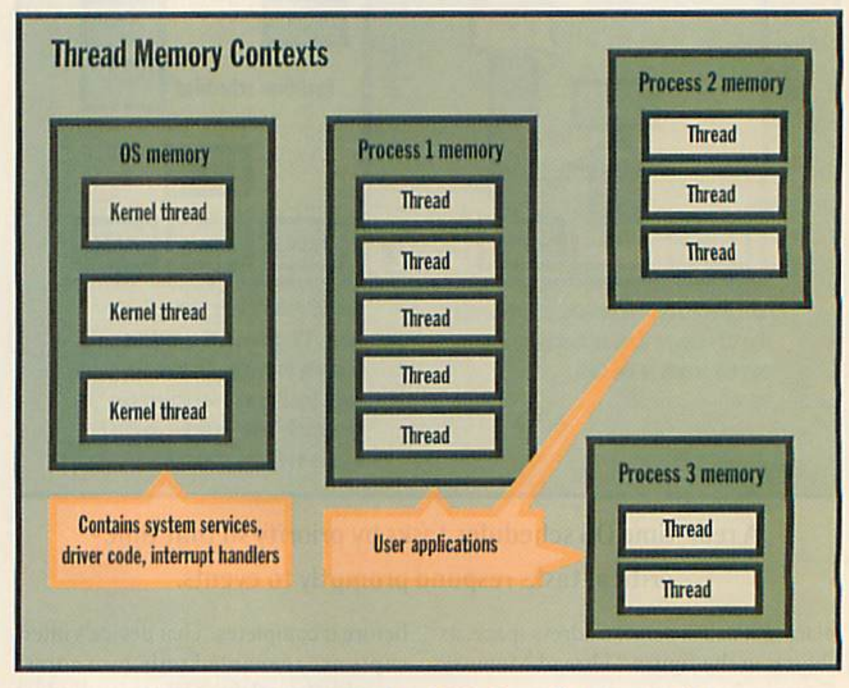
• **High-performance OS facilities** must execute quickly, with fast response to interrupts, to keep the system overhead low and predictable.

• **Memory protection** makes applications more reliable by ensuring that programs don't corrupt each other's code and data, or even the OS's code and data.

• **Modular architecture** provides scalability so that the OS can be tailored for a wide variety of embedded applications, without sacrificing real-time performance. Key features such as TCP/IP, NFS, demand paging, and other extensions can be added or removed as necessary for a specific target environment. The LynxOS kernel can be configured to just under 200 KB of code.

• **Compatibility with existing standards such as Unix and Posix** provides well-known APIs for programmers to work with and encourages code reuse.

The basic design of LynxOS involved key decisions to achieve these goals. First, the entire kernel had to be preemptive and reentrant, so that time-critical tasks execute promptly. A time-critical task gets high priority so it always can preempt a lower-priority task, even while the latter uses a system service. The kernel's reentrant code also lets this higher-priority task use system services, even when the preempted task has made identical system calls.



Both user programs and OS threads execute in their own protected memory spaces.

Second, the kernel supports multithreading. Not only can user programs create multiple tasks at will, but device drivers and other kernel services can create their own tasks, which are called *kernel threads*. Kernel threads allow more effective scheduling of interrupt handling. That's because certain code—such as network or disk I/O—that used to be part of an interrupt handler can now go in a kernel thread, scheduled so that it

doesn't interfere with real-time processing. You can, therefore, schedule time-critical user tasks to execute at a higher priority than a device driver's kernel thread, so that these user tasks can respond rapidly to events. Global scheduling of all threads, user and kernel, is based solely on priority.

Third, LynxOS uses a processor's page memory management unit (MMU) to provide each instance of a user program its own protected logical address space. The MMU also protects the kernel by placing it in a separate address space, as shown in the figure "Thread Memory Contexts" on the previous page.

Last, instead of creating a proprietary API, the design team chose the Unix and Posix APIs, allowing a rich variety of Unix programs to be ported to LynxOS and offering a shallow learning curve for those programmers already familiar with the interface.

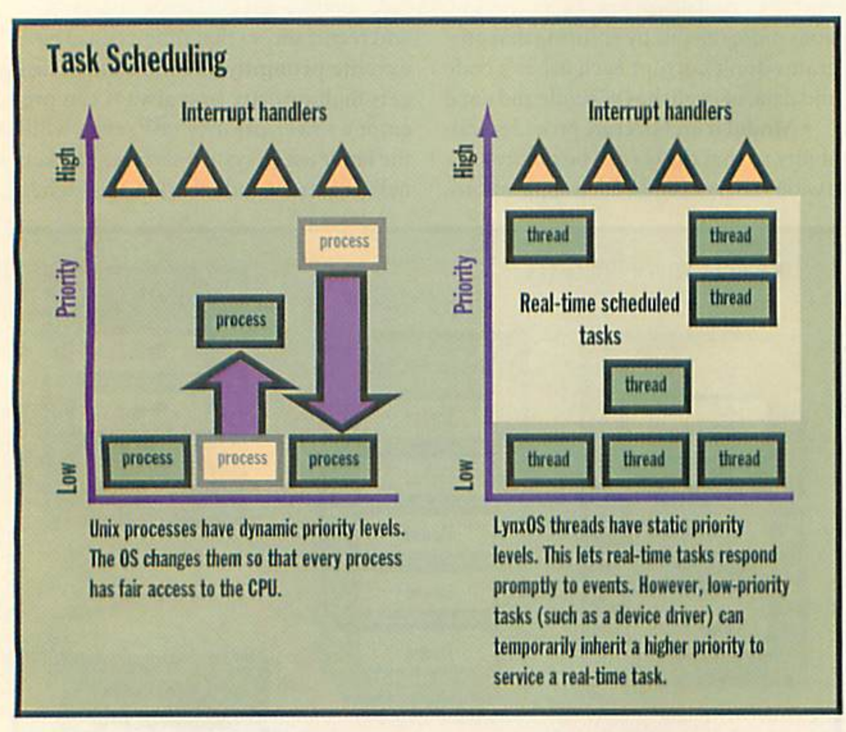
Real-Time Issues

In a real-time system, certain tasks must be completed within specific deadlines to respond to real-world events. For example, an embedded controller that adjusts the tension in a factory conveyor belt to compensate for a constantly changing load must respond promptly, or the belt may grind to a halt or break.

A real-time OS supports the real-time application's ability to meet its timing deadlines. LynxOS makes this possible by providing fast context switching plus low system call overhead. This helps keep short the execution time of every task.

The LynxOS interrupt system keeps short an interrupt routine's execution time and even bounds the number of interrupts that can occur during the execution of a high-priority task. This is done by having the interrupt handler disable further interrupts from the device before it completes. That device's interrupts are reenabled only by a corresponding kernel thread that actually does most of the interrupt processing. This kernel thread's priority is based on the priorities of the user threads that access the device.

LynxOS contains no system-level tasks that *must* run at higher priority than user tasks. This is possible because task scheduling is interrupt-driven. There is no single task responsible for scheduling other tasks. If the highest-priority task on the system is a user task and it doesn't release the processor, then nothing else runs. Of course, only tasks that must respond promptly or run for a short period of time should execute at very high priority.



A real-time OS schedules tasks by priority so that time-critical tasks respond promptly to events.

Multithreaded Model

Although the Unix process model was used as a basis for LynxOS processes, all tasks under LynxOS are represented internally as threads. A "process" is really just one thread (or more) that has its own protected logical address space. Since a LynxOS process has its own memory context, it is completely shielded from memory corruption by address errors in other processes.

LynxOS uses the standard Unix process model for process creation, destruction, and manipulation. The key difference is that LynxOS threads execute strictly at static, user-set priorities, not at dynamic, varying priorities based on CPU execution or I/O blocking as with Unix. The reason for this is that the Unix model has a concept of "fair-share" scheduling. Processes that perform lots of I/O and consume little CPU time are given the CPU more often (that is, their priority is raised above others *by* the OS) than are CPU-bound processes. This sort of dynamic priority manipulation would be disastrous in a real-time environment where no such policy exists. In fact, scheduling in the ideal real-time environment is completely unfair. Priorities are static and based strictly on time criticality of the tasks, as shown in the figure "Task Scheduling."

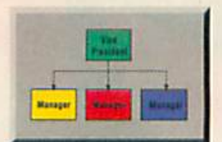
Just in Time

With real-time designs becoming more and more ambitious every year, it has become necessary to use 32-bit processors to provide the throughput required by these applications. Effective use of these processors demands rethinking the role the OS plays in a design. LynxOS has been tailored specifically to deliver everything the 32-bit world offers without sacrificing real-time predictability. It also is compatible with System V and BSD Unix, and is Posix-compliant, so that software designers can use a familiar set of APIs and development tools to create real-time solutions. **B**

WHERE TO FIND

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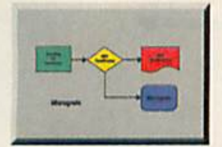
Vik Sohal works in technical sales at Lynx Real-Time Systems. You can reach him by sending e-mail to **vik@lynx.com**. *Mitchell Bunnell is the chief technology officer at Lynx. You can reach him at* **mitch@lynx.com**.



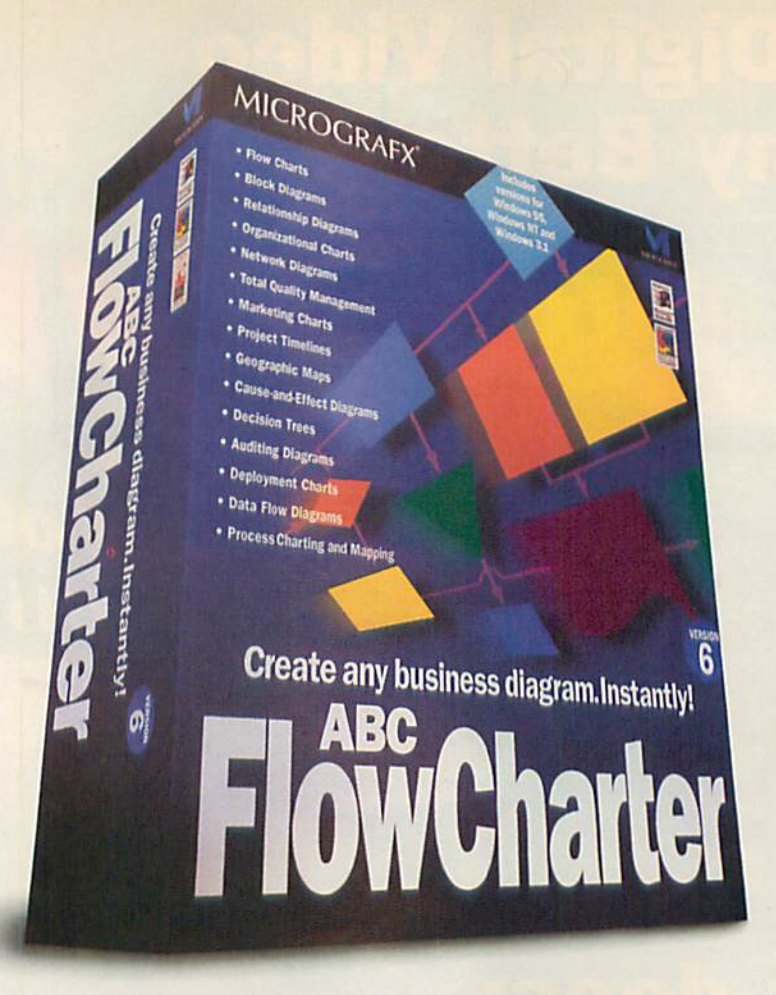
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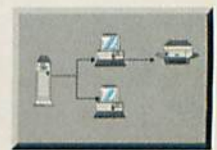




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Enhancements to the Internet Protocol let it support more addresses and handle Web functions. ***By William Stallings***

The New and Improved Internet Protocol

With the changing nature of the Internet and of business networks, the current Internet Protocol (IP)—the backbone of TCP/IP networking—is becoming obsolete. Until recently, the Internet and most other TCP/IP networks provided support for relatively simple distributed applications, such as e-mail, file transfer, and remote access using telnet.

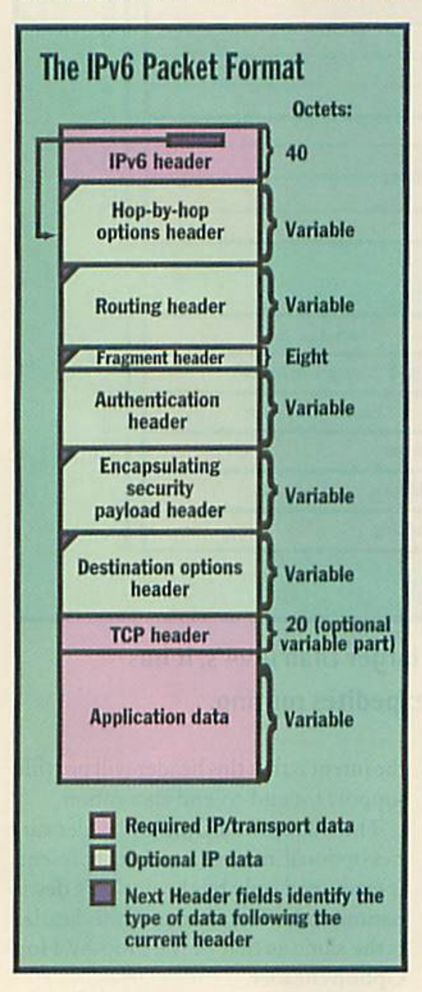
Today the Internet is increasingly becoming an application-rich multimedia environment, led by the overwhelming popularity of the Web. At the same time, corporate networks have branched out from using simple e-mail and file transfer applications to using complex client/server environments.

All these developments have outstripped IP-based networks' capability to supply needed functions and services. An internetworked environment needs to support real-time traffic, flexible congestion-control schemes, and security features. None of these requirements is easily met with the existing IP standard, known as IPv4. But the major driving force behind the development of a new IP standard is the stark fact that because of the current standard's fixed 32-bit address length, the world is running out of IP addresses for networked devices.

The Next-Generation Standard

To meet all these needs, in July 1992 the Internet Engineering Task Force (IETF) issued a call for proposals for a next-generation IP (IPng). A number of proposals were received, and by 1994, the final design for this IPng emerged.

A major milestone was reached with the publication of RFC 1752, "The Recommendation for the IP Next Generation Protocol," issued in January 1995. RFC 1752 outlines the requirements for IPng, specifies the header formats, and highlights the IPng approach in the areas of addressing, routing, and security. Other Internet documents defined details of the protocol, which is now officially known as IPv6; these include an overall specification of IPv6 (RFC 1883) and several RFCs (1884, 1886, and 1887) dealing with addressing aspects of IPv6.



A fixed header size and optional special-function headers reduce router processing.

IPv6 includes the following enhancements over IPv4.

Expanded address space. IPv6 uses 128-bit addresses instead of IPv4's 32-bit addresses, which increases the address space by a factor of 2^{96}. This enlarged space provides room for numerous device addresses, even if they are allocated in an inefficient manner.

An improved option mechanism. IPv6 places packet options in separate headers located between the IPv6 header and the Transport Layer header. It's important that routers along the packet's path don't have to examine or process many of these option headers. This simplifies and speeds up router processing of IPv6 packets compared to IPv4 datagrams. It will also make it easier to add new options in the future.

Address auto-configuration. This capability provides for dynamic assignment of IPv6 addresses.

Support for resource allocation. Instead of using IPv4's type-of-service field, IPv6 can label packets that belong to a particular traffic flow for which the sender requests special handling. This aids in the support of specialized traffic, such as real-time video, where image frames must be delivered to a destination as rapidly as possible.

Security capabilities. IPv6 includes features that support authentication and privacy.

The IPv6 Packet

The basic unit of transfer in IPv6 is the packet, as shown in the figure "The IPv6 Packet Format" at left. A packet typically encloses a TCP segment, which in turn consists of a TCP header and TCP user data. IPv6 adds to this a fixed-length IPv6 header and a number of optional extension headers. The advantage of the multiple-header structure is that when optional IPv6 functions aren't used, a streamlined packet can be sent.

Each extension header is designed to

provide support for an optional function (or a related set of them). The Hop-by-Hop Options header carries additional information that, if present, must be examined by every router along the path. Thus far, the only defined option is the Jumbo Payload option, which is used to send IPv6 packets with payloads longer than 2^{16} octets, or 65,535 bytes.

The Routing header provides extended routing, which is similar to IPv4 source routing. This header contains a list of one or more intermediate nodes to be visited on the way to a packet's destination.

The Fragment header contains fragmentation and reassembly information. In IPv6, fragmentation is performed only by source nodes, not by routers along a packet's delivery path.

To take full advantage of the internetworking environment, a node performs a path-discovery algorithm that enables it to learn the maximum transmission unit (MTU) that's supported by each subnetwork on the path. With this knowledge, the source node fragments the packet for each given destination address. Otherwise, the source node limits all outgoing packets to 576 octets, the minimum MTU size that each subnetwork supports.

The Authentication header provides packet integrity and authentication. IPv6 does not dictate a specific authentication algorithm; therefore, a variety of approaches can be implemented by different organizations.

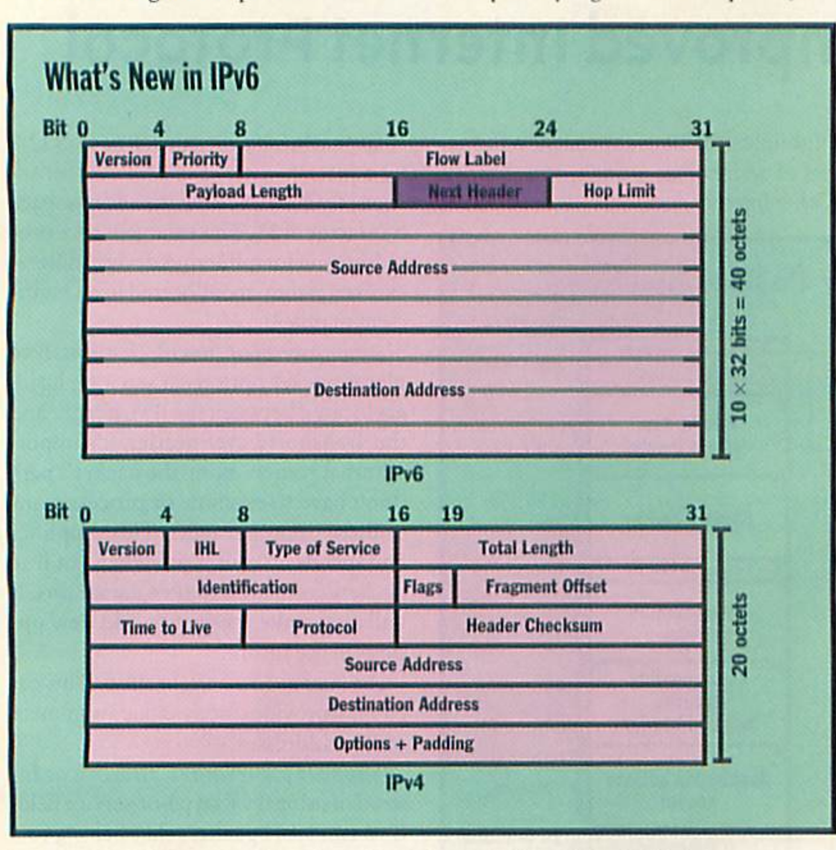
The Encapsulating Security Payload header provides privacy. Again, no specific privacy algorithm is required, but the intent is that this header will provide support for end-to-end encryption.

The Destination Options header carries optional information that, if present, is examined only by the packet's destination node. The format of this header is the same as that of the Hop-by-Hop Options header.

The IPv6 Header

The figure "What's New in IPv6" above shows the IPv6 header and how it differs from the IPv4 header. The new header is a fixed 40 octets long, compared to the IPv4 header's 20 octets and variable-length options field.

Some of the fields in the IP header, such as those related to fragmentation, are moved to extension headers in IPv6. Others, such as the header checksum, have been abandoned.



While the IPv6 header is larger than IPv4's, it has fewer fields; this expedites routing.

The IPv6 header fields include the following:

Version (4 bits). The IP version number; the value is 6.

Priority (4 bits). The priority value for this packet.

Flow Label (24 bits). A host uses this field to request that a network's routers perform special handling on the packet.

Payload Length (16 bits). The length of the remainder of the IPv6 packet following the header, in octets. In other words, this is the total length of all the extension headers plus the TCP segment.

Next Header (8 bits). Identifies the type of header immediately following the IPv6 header.

Hop Limit (8 bits). The remaining number of allowable hops for this packet. The hop limit is set to some desired maximum value by the source and is decremented by 1 by each node that forwards the packet. The packet is discarded if the Hop Limit count reaches 0. This is a simplification of the processing required for IPv4's time-to-live field.

Source Address (128 bits). The address of the originator of the packet.

Destination Address (128 bits). The address of the intended recipient of the packet.

Although the IPv6 header is longer than the mandatory portion of the IPv4 header (40 octets versus 20), it contains fewer fields (eight versus 12). Thus, routers have less processing to do per header, which should speed packet routing.

IP's Progress

With the technical details of the IPv6 standard now set in stone, vendors can begin incorporating its capabilities into their product lines.

As IPv6 is gradually deployed, the Internet and corporate networks will be able to handle more addresses, new functions, and new data types. This will allow the next-generation IP protocol to remain the foundation for networked applications in the twenty-first century. ■

William Stallings is a consultant, lecturer, and author of over a dozen books on data communications and computer networking. This article is based on material from his most recent book, Data and Computer Communications *(Prentice-Hall, 1996). You can reach him at* **http://www.shore.net/~ws/welcome.html** *or at* **ws@shore.net**.

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A new architecture designed for low-cost printers requires an inexpensive yet powerful processor. ***By Andrew Shaw***

How PrintGear Works



Adobe got its start with its PostScript page-description language (PDL), a rich set of resolution- and device-independent graphics operators that assemble an image on the printed page. Its versatility and device-independence have made PostScript a standard on output devices ranging all the way from ink-jet printers to printing presses.

However, PostScript's very sophistication makes it a big-ticket item on a low-cost printer. That's because implementing the PostScript interpreter requires the equivalent of a separate computer inside the printer. If the small office/home office (SOHO) market is going to benefit from high-resolution graphics and text, a different—yet affordable—printing technology is necessary.

Adobe's PrintGear technology is a new printing architecture designed specifically for low-cost, high-quality output. At the core of this architecture is a custom chip, the PrintGear Imaging Processor (or PrintGear processor for short). This processor supplies the performance required for high-resolution output, yet helps keep the overall cost of the output device low.

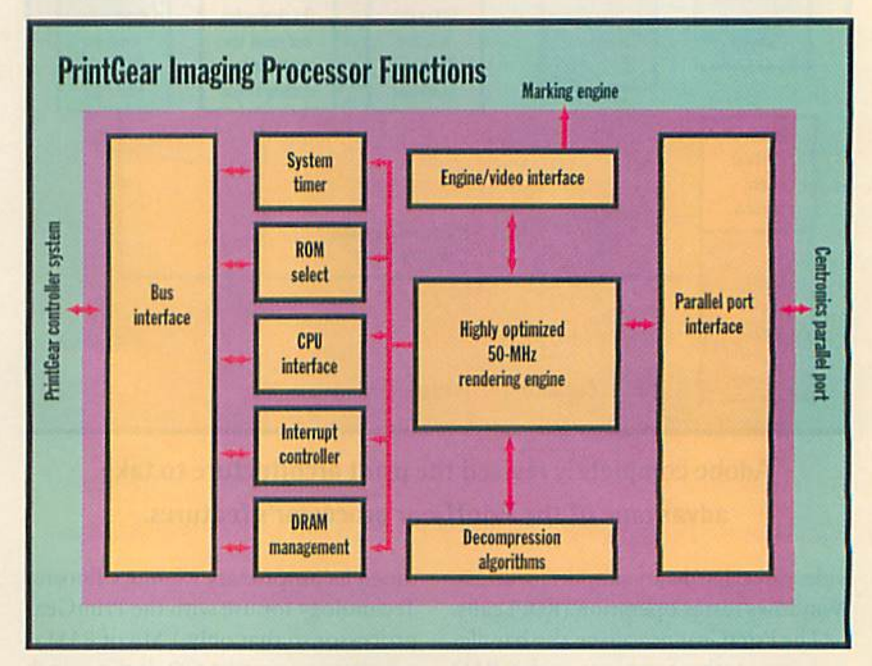
PrintGear Goals

The PrintGear design team faced two opposing goals. First, the printing architecture had to offer high performance, great print quality, and unique features such as status feedback and cross-platform support. The second design goal ran counter to this: The technology had to be inexpensive.

It quickly became apparent that achieving such ambitious goals would require a top-to-bottom redesign of every component involved in the printing process. This included the printer software, the printer firmware (the programs that execute in the printer), and the printer hardware itself. By using custom-designed hardware that places just the right amount of smarts into the printer, the team hoped to achieve the speed and quality associated with much more expensive printers. Also, the custom hardware would eliminate a number of parts in the design, thus keeping the printer affordable.

Building a New Printer

This custom hardware made it necessary to come up with a radically new design for the printer's controller board. A printer controller board—which implements that separate computer mentioned earlier—typically contains a processor of some sort to run the firmware programs; ROM to hold the firmware; and RAM to hold downloaded fonts, the page image, and working data. Then there's the all-important support electronics for things such as memory and I/O controllers. With all this stuff, the controller board contributes significantly to the printer's cost.



Adobe's processor implements high-speed imaging operations and system bus control signals.

PrintGear's key innovation borrows the fundamental idea behind RISC processors and applies it to printing. RISC processors support only a small set of commonly used instructions, but those instructions execute at very high speed. The PrintGear Imaging Processor's design resulted from analysis that showed that the most commonly printed SOHO documents use only a few basic imaging primitives. The engineering team optimized the PrintGear chip so that its hardware supports the high-speed rendering of these basic imaging primitives. Text, for example, is one of the most common basic imaging objects for SOHO printing. Adobe made a special effort to ensure that

this class of objects was rendered at the highest possible speed. As a result, the processor can render text at over 75 million pixels per second.

Similarly, where RISC processors typically have a very complete set of instructions for common operations such as loading and storing data, the PrintGear processor has a complete set of raster imaging instructions needed for most printing tasks. For example, the chip provides direct hardware support for all 256 Windows raster operation (ROP) calls.

The PrintGear processor also handles a variety of other functions, such as RAM and ROM addressing, system timing, and parallel port I/O. For instance, the parallel port's 25 signal lines run directly into the processor, and are managed by it. The diagram "PrintGear Imaging Processor Functions" shows the main functions handled by the processor. Rolling all these functions into the PrintGear processor eliminated the number of support chips required on the controller board, thus reducing its overall cost.

Adobe completely revised the print architecture to take advantage of the PrintGear processor's features.

The PrintGear Controller

To lower printer costs further and to maintain good performance, Adobe produced a "reference system" schematic, dubbed the PrintGear controller, that supplies the remaining support hardware. The printer vendor uses this schematic to build an actual controller board. Since the schematic is based on the PrintGear processor, inexpensive ROM, RAM, and CPU can be used in the controller board's design.

Because the PrintGear processor directly implements a large number of imaging operations, the PrintGear controller's firmware—which includes the Printer Control Language (PCL) interpreter—fits in less than 256 KB. Adobe tuned its proprietary Memory Booster Technology for use with the PrintGear processor so that only 1 MB of RAM is necessary to support 600-dots-per-inch (dpi) printing. And because the PrintGear processor already incorporates so many system functions, a low-cost, 16-MHz Motorola 68EC000 was sufficient for other CPU tasks.

The biggest job the 68EC000 chip takes care of is the built-in PCL 4.5 emulation. Since the 68EC000 runs the emulation with plenty of cycles to spare, it can also handle other housekeeping chores. Such jobs include display list preprocessing, page pipelining, automatically detecting the printer language, managing memory, and relaying printer and job status back to the user.

The Software Side

Building so many functions into the PrintGear processor meant that the rest of the PrintGear architecture could be optimized to take advantage of it. The diagram "The PrintGear Printing Process" at left shows how the other parts of the printing system work with the PrintGear processor.

A print job starts when a user chooses the Print command. The operating system's graphics subsystem (Graphical Device Interface (GDI) in Windows, QuickDraw on the Macintosh) passes the application's calls through to the PrintGear printer driver. The PrintGear driver then converts these image object calls into PrintGear imaging operators. The result is a very compact page description, or display list. Typical objects represented in the PrintGear display list include bit maps, characters, lines, simple geometric shapes, and patterns. This page description is then transmitted to the printer using standard I/O mechanisms.

Fast I/O rates are unnecessary for high-performance output because PrintGear print files are typically very small (about 44 KB for a spreadsheet page). However, the PrintGear controller is capable of accepting data at very high speeds (up to 200 KB per second) and still render the printed page on-the-fly. This ability to accept print data at a wide range of speeds means that PrintGear printers can work in a variety of environments, including direct connection (serial or parallel), Macintosh LocalTalk connections, printer-sharing devices, and networks.

The Plummeting Price of Printing

Integration of the PrintGear processor into the PrintGear architecture means that the performance and quality formerly associated with business-class printers retailing for around $800 can now be offered in a SOHO printer that sells for less than $500. It is noteworthy that the first PrintGear printer—the NEC SuperScript 860—sells for around $499. It offers resolution of 600 dpi resolution and print speed of 8 pages per minute. (For our review of the SuperScript 860, see "Quality Printing, Fast and Cheap" on page 47.) These performance gains and cost reductions result directly from the printer's use of the PrintGear Imaging Processor and the new Adobe PrintGear printing architecture. ■

Andy Shaw is a technical product manager in the Personal Printing Group at Adobe Systems. You can reach him at **ashaw@adobe.com.**

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Knowing how Java's dynamic linking works can help you improve a program's performance. By Peter Wayner

Better Java Programming

There's a certain irony in that Sun's Java started life as an embedded programming language, yet it now makes reusable and transportable code a reality on the Internet. Java applets are relatively small but powerful units of code that can travel across the network and link themselves to class libraries that reside on the host computer. However, this flexible linking mechanism exacts a price: It allows easy code migration at the expense of performance. Optimizing compilers can boost the speed of Java programs, but you can help with judicious program design.

The key to understanding the performance trade-off incurred by this dynamic linking mechanism is to study Java's method invocations (object-oriented procedure calls) in depth. Java has highly structured method invocations. If a programmer invokes a `foo()` method, the interpreter must determine the correct version of the `foo()` method to use. That's because `foo()` could be defined by the applet itself, or it might inherit `foo()` from the host computer's libraries or from another object downloaded off the Net.

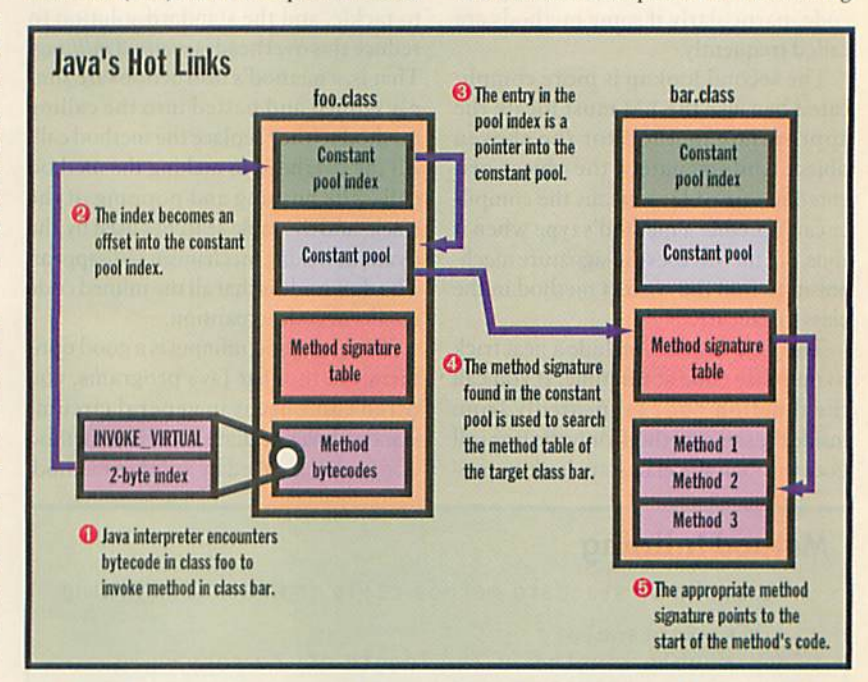
This situation differs from languages like C++, where a compiler scans the source code and resolves the correct method out of several. Then it embeds a pointer to this method within the generated machine code. This *static linking* works well for self-contained programs that run locally on only one machine. However, moving a program to another system requires copying all of the program, not just a portion of it. Also, if a new class inherits properties from an existing class, then the source code must be recompiled so that the linker can reevaluate all the method calls. Because Java's dynamic linking mechanism resolves the correct method at run time, it enables preexisting code modules to migrate to a new machine and link up quickly with the local code libraries.

When a Java program is "compiled," it is converted into bytecodes for interpretation on a hypothetical virtual machine (VM). Each computer runs its own VM implementation locally, and this is where the dynamic linking happens. Four different bytecodes, as described by the Java VM specification, handle executing a method. Each bytecode applies to a different method type. The most common bytecode is known by the label `INVOKE_VIRTUAL`, and it handles most method calls. The call is dispatched based on the run-time (or virtual) type of the object that owns the method.

Dynamic Links

How does Java establish the run-time links with programs that have just come from the Internet? Objects in these programs get loaded into a pool of constants located in memory. This pool, called a *class constant pool*, stores data constants, program bytecodes, class descriptions, and method descriptions. The text string of each method's name, combined with extra information, is encoded and stored in a *method signature table* in the program's constant pool.

When the Java VM executes a program and encounters an `INVOKE_VIRTUAL` bytecode, it pushes the method's parameters and a pointer to the object onto the stack. A 2-byte reference number follows the `INVOKE_VIRTUAL` bytecode, which the Java VM uses as an index into the calling object's constant pool to obtain the method's signature. The VM uses the pointer on the stack to locate the target object's method table. It searches



Downloaded objects can link to other Java libraries dynamically and inherit or override their behavior.

this table until it finds a method block with the proper signature. This *method block* contains information as to the method's type, how its call is set up, and where its code is located in memory (as shown in the figure "Java's Hot Links" on the previous page). With the start address of the appropriate method in hand, the Java virtual machine begins executing it and retrieves the arguments off the stack.

The amount of indirection here is a product of compromise. The first indexed lookup into the constant pool is necessary in order to limit the size of the compiled code. Only 2 bytes are needed to specify the correct method, while searches based on a name string require both more storage as well as more cycles. The result is more compact program code, particularly if some methods are called frequently.

The second lookup is more complicated because the VM must locate the appropriate method for the chosen object. Unfortunately, the object-oriented nature of Java means the compiler can't predict a method's type when it runs. So, the VM uses the signature mechanism to find the correct method in the class to execute.

The Java VM does include a neat trick to optimize code at run time. If you call the function `foo()` repeatedly from inside the same method, only the first call goes through the elaborate lookup process. Subsequent calls become much faster because the VM substitutes `INVOKE_VIRTUAL_QUICK` bytecodes in place of the `INVOKE_VIRTUAL` bytecodes. The index bytes after this `QUICK` version are already decoded references to the method. The Java VM specification suggests that this optimization occur automatically on-the-fly, but different Java implementations might approach this differently.

Speed Tricks

It should be clear that the dynamic links established for methods in a Java program are much more involved than for a statically linked language like C++. The overhead for switching the processor state between functions is still one of the biggest problems for compiler writers to tackle, and the standard solution to reduce this overhead is *method inlining*. That is, a method's instructions are simply copied and pasted into the calling method so they replace the method call. All the overhead in making the method call—the pushing and popping of the stack, and the table searches used by the dynamic linking mechanism—disappear. The downside is that all the inlined code results in code expansion.

While method inlining is a good optimization tool for Java programs, you often can't use it in general circumstances. Imagine that a class has a method `foo()` that is called by another method, `bar()`. At compile time, there may be no other subclasses that replace `foo()`, so it would be perfectly fine to inline the instructions for `foo()` inside of `bar()`. But Java is flexible enough so that another subclass could come along later and override `foo()`. The Java compiler must be ready to deal with these situations, so no inlining can take place.

Java's designers realized this flexibility would have an impact on performance, so they provided a keyword that allows you to forgo this flexibility. If you declare a method `final`, you indicate to the compiler that no other subclasses will try to define their own version of the method. When the compiler knows this, it can inline processes. Any attempt to override a `final` method generates a compile-time error.

If you write Java code, you should make liberal use of the `final` keyword. Many programmers use short methods because it makes their code more readable. Unfortunately, this can significantly increase the execution time because of a method's calling overhead. The `final` keyword eases the burden.

The code fragment in "Method Inlining" (below left) shows a sample class called `Rectangle`. In this case, the `final` keyword isn't used, so the Java compiler can't inline the code for `FindArea()` into `FindPaintCost()`. If it did, the result would look like the function `FindPaintCostInline()`. While the result is that the method can't be optimized, it means you can override the behavior of `FindArea()` in the future (to calculate the area of a cylindrical tank, for example). The trade-off, then, is either better performance or code flexibility. You must decide which is most important to the program's operation in that situation.

Although Java looks very similar to C++ on the surface, the language is intended to be used differently than conventional programming languages. What might work for a C++ program can impair performance in a Java program. A Java program with many small methods can hamper performance due to the method-calling overhead. Armed with this knowledge and the `final` keyword, you can improve the performance of your Java applets. ■

Method Inlining

```
// Example of standard method calls and method inlining

  class Rectangle{
     double length; // The length of the rectangle.
     double height; //Its height.

     double FindArea(){
        return length*height;
     }

     double FindPaintCost(){
        int area;
        area = FindArea();
        return area*4;
           // Cost is 4 times the area.
     }

     final double FindPaintCostInline(){
        int area;
        area = length*width;
        return area*4;
           // Cost is 4 times the area.
     }

}
```

BYTE consulting editor Peter Wayner's book Java and JavaScript Programming *will be published by AP Professional. You can reach him at* **pcw@access.digex.net**.

Break the Bandwidth Barrier

New high-speed modems that operate over cable TV networks and ordinary phone lines will give an unprecedented amount of affordable bandwidth to everyone.

By Tom R. Halfhill

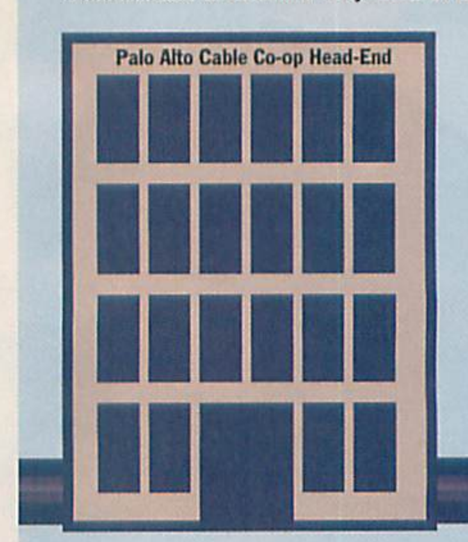
Imagine that you could buy a desktop computer with a 15,000-MHz processor, 1600 MB of RAM, and a 100-GB hard drive for less than $20. Sure, you could run Word a little faster and recalculate wall-size spreadsheets in the blink of an eye. However, the real impact of that much power at such a breakthrough price would be almost impossible to predict, because it's the kind of breathtaking leap that spawns new applications that weren't thinkable before.

On-line bandwidth is on the verge of making just such a leap. The mythical system described above is about 100 times faster than today's PCs at one-hundredth the cost, and that's approximately the price/performance advantage that a new generation of broadband modems will deliver over existing phone lines and cable TV networks. Compared to the latest analog modems, it's a quantum leap in affordable bandwidth that spans two orders of magnitude for about one-hundredth the cost of a T1 dedicated phone line. Never before in the history of computing has there been such a jump. Microprocessors grow about twice as powerful only every 18 months, and analog modems are only about 10 times faster than they were 20 years ago.

This comes not a minute too soon. The Internet boom has exposed the soft, white underbelly of the Net: agonizingly slow access through traditional analog modems. The supposed savior of the Internet is an unlikely hero: a squat, little box

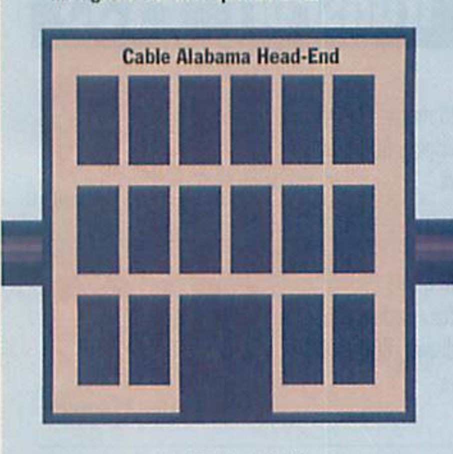
Building a WAN with Cable Modems

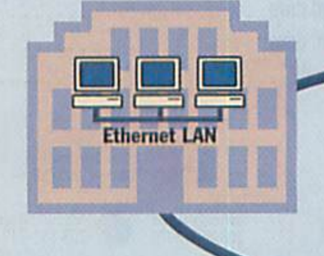
Three schools in Palo Alto, California, share T1 access to the Internet over a WAN that uses the local cable TV system as its high-speed backbone.

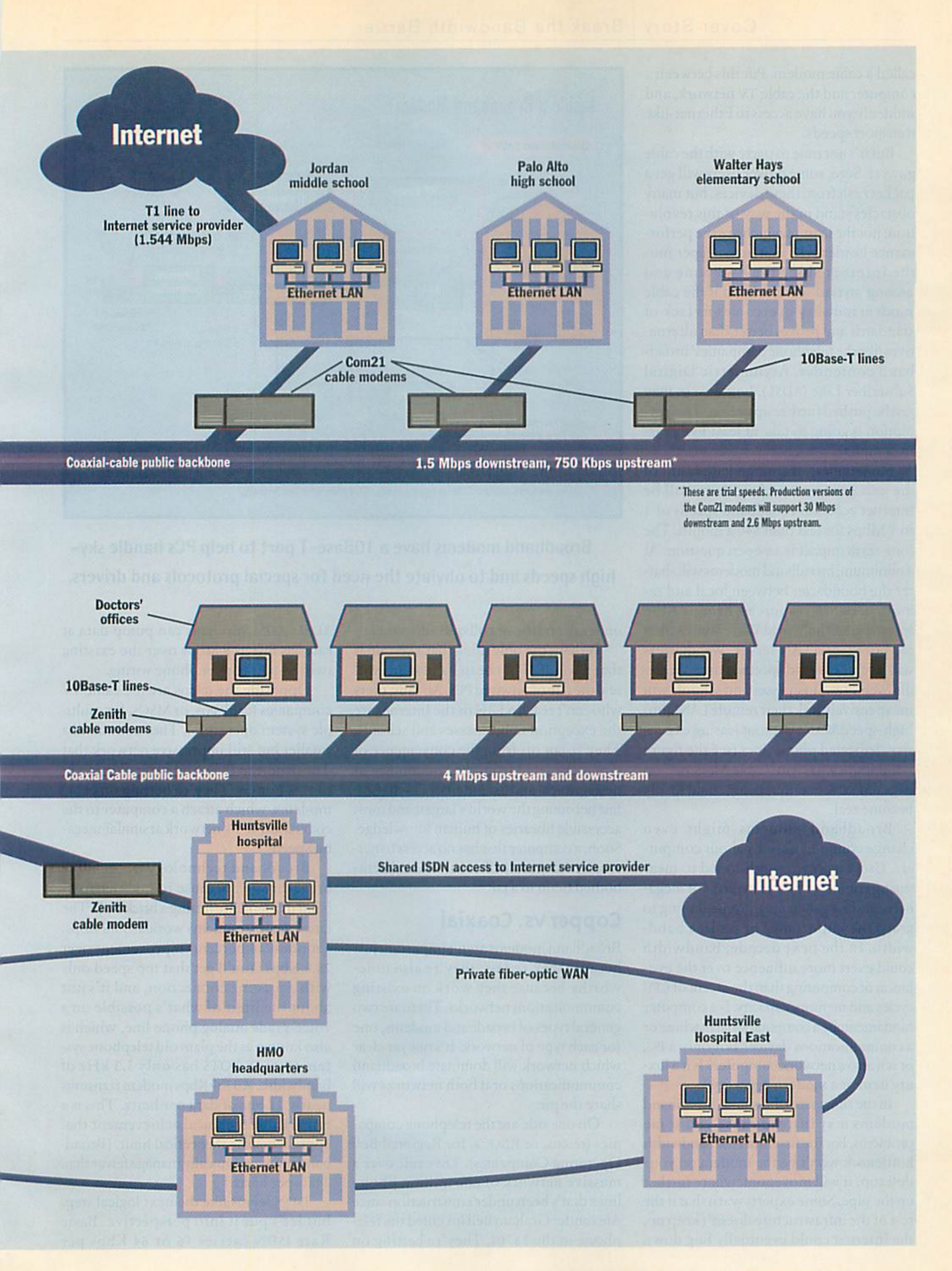


Extending a WAN with Cable Modems

A hospital system in Huntsville, Alabama, is using the local cable TV system to extend its fiber-optic WAN to more than 200 doctors throughout the metropolitan area.







Broadband modems have a 10Base-T port to help PCs handle sky-high speeds and to obviate the need for special protocols and drivers.

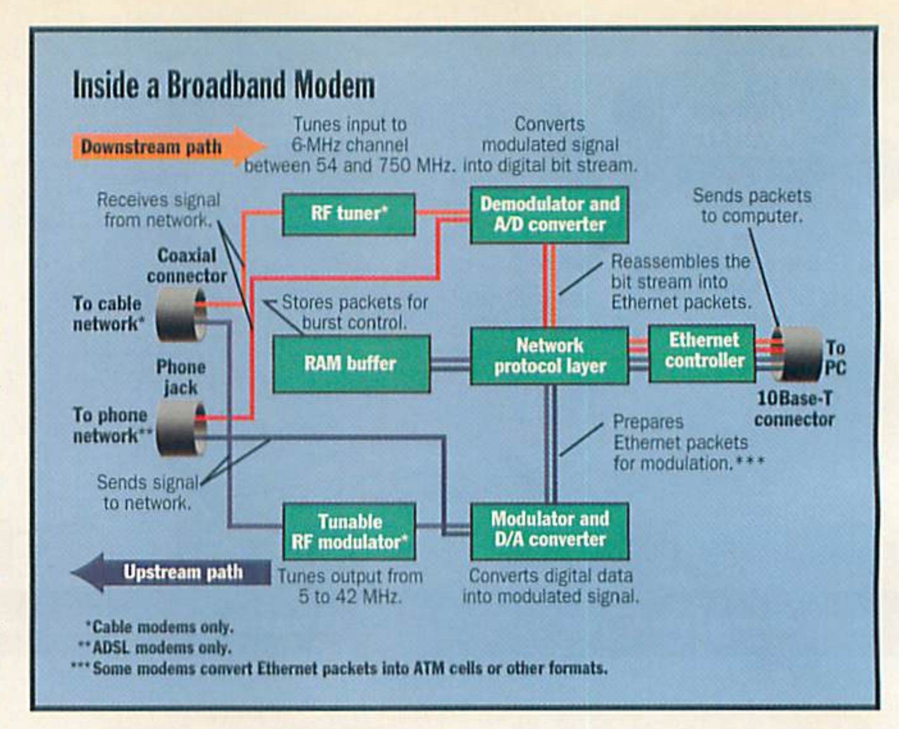
called a cable modem. Put this between a computer and the cable TV network, and suddenly you have access to Ethernet-like transport speeds.

But it's not time to party with the cable guy yet. Sure, some power users will get a packet rush from these devices, but many obstacles stand in the way of this revolution, not the least of which are the performance bottlenecks that lurk deeper into the Internet along the backbone and among myriad servers. Even if the cable modem industry overcomes its lack of standards and proves better than alternatives like the telephone companies' broadband contender, Asymmetric Digital Subscriber Line (ADSL), bottlenecks may just be pushed further upstream. This revolution is going to take at least five years to complete.

Nonetheless, the immediate result of the new generation of modems will be Internet access at broadband speeds of 1 to 5 Mbps for less than $40 a month. The long-term impact is an open question. At a minimum, broadband modems will shatter the boundaries between local and remote network resources, bringing the Internet and the World Wide Web as near to your PC as a LAN server. Webmasters will be able to build spectacular multimedia Web sites. Businesses and schools will inexpensively link their remote LANs into high-speed WANs without leasing expensive dedicated phone lines (see the figure "Building a WAN with Cable Modems" on page 68). Videoconferencing could finally become real.

Broadband modems might even change common notions about computers. Users who are conditioned to measuring computer power in terms of megahertz and megabytes are just beginning to grasp the importance of on-line bandwidth. In the next decade, bandwidth could exert more influence over the evolution of computing than the ascent of CPU cycles and memory capacity. Is a computer fundamentally a computational machine or a communications device? Is it only a PC, or is it also a network computer? Is it a luxury item or a modern necessity?

In the short term, however, broadband modems may instead cause you some problems. For the first time, the bandwidth bottleneck won't be the modem on your desktop; it will move somewhere further up the pipe. Some experts warn that if the rest of the infrastructure doesn't keep up, the Internet could eventually bog down under the traffic or collapse altogether.



Broadband modems have a 10Base-T port to help PCs handle sky-high speeds and to obviate the need for special protocols and drivers.

Perhaps the only thing that's certain is that a windfall of cheap bandwidth will seal the fate of unwired PCs. Already, users who can't reach a LAN or the Internet are the exception in businesses and schools. They're cut off from the convenience of e-mail, isolated from the community of newsgroups, and excluded from what are fast becoming the world's largest and most accessible libraries of human knowledge. Soon, a computer that has no access to network resources will seem like a disembodied brain in a jar.

Copper vs. Coaxial

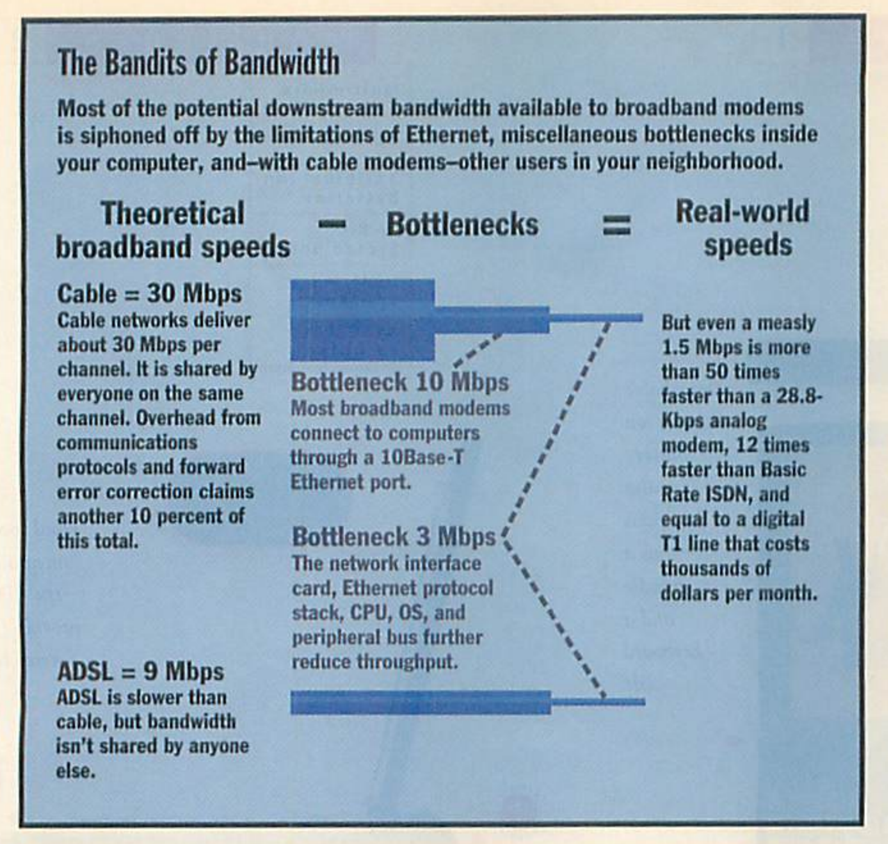
Broadband modems aren't important just because they're fast; they're also noteworthy because they work on existing communications networks. There are two general types of broadband modems, one for each type of network. It's not yet clear which network will dominate broadband communications or if both networks will share the pie.

On one side are the telephone companies (telcos, or RBOCs, for Regional Bell Operating Companies). They rule over a massive network of 600 million phone lines that's been under construction since Alexander Graham Bell invented the telephone in the 1870s. They're betting on ADSL. ADSL modems can pump data at rates as fast as 9 Mbps over the existing twisted-pair copper phone wiring.

Opposing the telcos are the cable TV companies (cablecos, or MSOs, for multiple system operators). They command a smaller but still impressive network that dates from the 1960s and covers 90 percent of U.S. homes. They're betting on cable modems, which attach a computer to the coaxial-cable TV network at similar megabit speeds.

Broadband technology is a genuine breakthrough because today's narrowband modems are hitting a brick wall. The latest analog modems work at 33.6 Kbps, a modest 16 percent improvement over 28.8 Kbps. You'll get that top speed only with a pristine connection, and it's just about the limit of what's possible on a voice-grade analog phone line, which is also known as the plain old telephone system (POTS). POTS has only 3.3 kHz of bandwidth. A 33.6-Kbps modem transmits nearly 11 bits of data per hertz. This is a remarkable technical achievement that approaches the theoretical limit. (Broadband modems typically manage fewer than 2 bits per hertz.)

ISDN seems like the next logical step, but let's put it into perspective. Basic Rate ISDN carries 56 or 64 Kbps per



B-channel, which is only about twice as fast as the latest analog modems. You can get as much as 128 Kbps with an ISDN modem that combines the two B-channels, but these middleband speeds aren't enough to propel on-line communications from the ASCII age into the future. Tomorrow's Web will be a lively and bandwidth-hungry world of streaming video, real-time audio, wide-area videoconferencing, Java applets, and 3-D Virtual Reality Modeling Language (VRML) environments.

Won't ISDN get faster, repeating the steady progress of analog modems? It's not likely. ISDN's inefficient baseband modulation wastes bandwidth, and significantly changing ISDN would be like reinventing ADSL. Thus, ISDN is merely a small step toward the ultimate destination.

Beyond Basic Rate ISDN are a number of higher-speed data-grade lines the telcos offer: Primary Rate ISDN (which bundles up to 24 Basic Rate B-channels to yield 1.5 Mbps), frame relay (56 Kbps to 1.536 Mbps), T1/DS1 (1.544 Mbps), DS2 (6.312 Mbps), Switched Multimegabit Data Service (SMDS)/DS3 (56 Kbps to 34 Mbps), STS-1 (51.840 Mbps), and others. There are also ADSL-like technologies, such as high-bit-rate digital subscriber line (HDSL), which usually require multiple twisted pairs to deliver megabit speeds.

Even more-enlightened telcos charge heavily for this bandwidth. Pacific Bell—an aggressive marketer of digital subscriber lines in Silicon Valley—charges $525 to more than $6400 a month, depending on the service, plus installation fees ranging from $2000 to $6500. Some telcos charge more. Clearly, these are not affordable solutions for most businesses, schools, and home users.

What about wireless? Some alternatives look interesting. DirecPC, from Hughes Network Systems, is a close cousin of DirecTV. The PC version transmits data from a geosynchronous communications satellite directly to a 24-inch dish antenna connected to your PC. The result is a highly asymmetrical network: 400 Kbps downstream. A standard analog modem carries upstream messages, so the maximum speed is 33.6 Kbps. The speeds are well short of what cable modems and ADSL offer.

Another broadband wireless option will be local multipoint distribution service (LMDS). This is a two-way digital broadcasting system that uses ground-based transceivers, not satellites. Unlike DirecPC, LMDS isn't available yet; it requires a huge chunk of RF spectrum that the U.S. government is expected to auction this fall. It's not clear yet who will buy this spectrum or how much they will pay, but it will be expensive. End users will need a special LMDS modem that attaches to an Ethernet port, which limits maximum bandwidth to 10 Mbps.

Both wireless alternatives require completely new infrastructures. Also, new wireless services must compete for a dwindling share of unallocated and extremely valuable broadcast spectrum. Meanwhile, there's virtually no limit to the amount of cable that the telecommunications industry can install if demand warrants.

Of course, cable modems and ADSL have their drawbacks, too. Some vendors brag about data rates "1000 times faster" than analog modems. As we'll see in a moment, actual performance varies quite a bit, for a wide variety of reasons. The bandwidth isn't equally apportioned, so there's more data flowing downstream (from the network to the user) than upstream (from the user to the network). Also, the telecommunications industry tends to gloss over the infrastructure upgrades it will inevitably face when deploying these technologies on a mass scale.

The fact is, neither ADSL nor cable modems are quite ready for prime time. Standards are shaky or incomplete, so modems from different vendors often can't talk to each other. Compared to analog modems, prices are relatively high (about $500). Only about 10 percent to 15 percent of the U.S. cable network can handle two-way traffic at megabit speeds. Business models are in flux because nobody knows just how much demand to expect.

Nevertheless, neither technology is vapor. Both types of modems are available. Numerous trials prove beyond a doubt that they work. In some cases, the trials are tantamount to actual deployments.

In 1997, standards will coalesce; manufacturers will drive down their costs and begin turning the modems into commodity products. By late in the century, spreading infrastructure improvements will make broadband modems available to millions of users. "We're looking at a five-year time frame," says analyst Larry Yokell, president of Convergence Industry Associates (Boulder, CO).

Too long to wait? Remember, we're talking about a historic leap in the distribution of bandwidth. Even by the most optimistic projections, the concurrent progress of microprocessors, memory



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Has It Changed Your Life Yet?

chips, and mass-storage devices won't come close. You might even hook up a broadband modem to the same computer you're using now.

How They Work

At first glance, broadband modems superficially resemble analog modems. They interface your computer to an external network and communicate with a compatible modem at the other end of the line by converting digital data into modulated RF signals. Likewise, they receive modulated RF signals and convert them back into digital data. These basic functions are common to all modems (see the figure "Inside a Broadband Modem").

What makes broadband modems so much faster is that they exploit a much wider swath of spectral bandwidth. Analog modems are limited to only 3.3-kHz POTS. By comparison, cable modems use the bandwidth of an analog TV channel, which is 6 MHz wide for NTSC and 8 MHz for PAL. Wider frequency exploitation translates into theoretical speeds of 8.448 Mbps and 30 Mbps for ADSL and cable modems, respectively.

These sky-high speeds would quickly overwhelm a computer's serial port. Consequently, most broadband modems require a 10Base-T Ethernet port. This also makes it easier to hook up a broadband modem, because it doesn't need special protocols or drivers—any standard Ethernet stack will do. From the computer's point of view, it's on an Ethernet LAN, not a special network.

The network interface card (NIC) sends Ethernet packets to the modem. The modem modulates the data and transmits it over the phone line or coaxial cable to the receiving modem at the other end of the connection. In the opposite direction, your modem converts the RF signals it receives back into Ethernet packets before sending them to the Ethernet card in your computer.

Some broadband modems send modulated Ethernet packets over the phone or cable network. Others convert the Ethernet packets into asynchronous transfer mode (ATM) cells or proprietary-format packets before modulating the signal. This lack of standardization is one reason why modems from different vendors usually aren't interoperable today. (For cable modems, the modulation schemes aren't standardized, either.) You need the same vendor's modem at each end of the line to communicate. It's as if you would need a different analog modem every time you change Internet service providers (ISPs) or move to an area that's served by a different telco.

This sorry situation probably won't last long. Several industry groups are working on interoperability standards to allow vendors to mass-produce broadband modems as low-cost commodity products. Eventually, both types of broadband modems will probably standardize on ATM as the network transport protocol and will dispense with 10Base-T connections in favor of internal cards that plug into expansion slots. Eventually, some PCs (and especially network computers) will integrate a broadband modem as a condensed chip set on their motherboards.

"I think we can get pretty close to one-chip digital signal processing with this thing," says Jack Guedg, director of National Semiconductor's multimedia systems strategic marketing segment. "That will drive down the price of cable modems tremendously. But that won't happen until we've got large volumes and industry standards."

In the meantime, almost all cablecos and some telcos are supplying modems to subscribers as part of their broadband service. Therefore, you won't get stuck with an obsolete modem. A monthly subscription fee of $30 to $40 will probably include the lease of a modem and unlimited Internet access. That's only $10 to $20 more than what most users are paying today for flat-rate access to the Internet at narrowband speeds. In most areas, middleband ISDN is a much more expensive option.

Your Mileage May Vary

What you don't get with ADSL—and particularly with cable modems—is an easily quantified amount of throughput. Realistically, you can expect 1 to 5 Mbps downstream and something less upstream. However, your actual throughput will vary according to a dizzying number of factors. These include the following: oddities in the cable and phone networks, asymmetric frequency allocations, unpredictable line noise, the speed of your computer and its Ethernet interface, and, with cable modems, the number of other people in your neighborhood who are on-line at the same time (see the figure "The Bandits of Bandwidth"). This isn't the case with ISDN, dedicated phone lines, and—to a lesser extent—analog modems.

How They Stack Up

Cable modems	30 Mbps
ADSL modems	9 Mbps
DS2	6.312 Mbps
T1/DS1	1.544 Mbps
ISDN PRI	1.5 Mbps
Frame relay	56 Kbps to 1.536 Mbps
ISDN BRI	56 to 128 Kbps
Analog modems	33.6 Kbps

Broadband modems sacrifice some of their potential speed to bring megabit service to more customers over existing infrastructures. It would be ridiculously easy to make superspeed modems if everyone had fiber-optic cable running into their premises. Eventually, that will happen. However, the need for broadband is more immediate. It doesn't make sense to postpone progress for an infrastructure upgrade that will take decades.

Phone Problems

The telcos originally designed their network to carry analog voice conversations from one phone to another. It's a pervasive network with versatile point-to-point circuit switching, but it's handicapped by antiquated wiring that plays havoc with digital data.

Take loading coils, for instance. Originally installed on long circuit loops to cancel noise during voice calls, they're essentially low-pass filters that cut off all frequencies above 4 kHz. Unfortunately, all digital modems require frequencies higher than 4 kHz. If there's a loading coil anywhere in the loop between the local distribution node and your premises, the phone company must remove it before you can get ISDN, ADSL, or any other digital service. Loading coils are the widely despised roach motels of digital networks: Bits check in, but they don't check out.

Loading coils aren't the only problem by far. Among other things, phone networks are plagued by overlong loops (which attenuate signals), bridged taps (unterminated pairs), and cross-coupled interference (cross talk between wires in

the feeder cables that run to neighborhood distribution nodes). Some of the wiring is so ancient that nobody has any idea how much of it might be compatible with digital service.

Tac Berry, vice president of marketing for Amati Communications, an ADSL modem vendor, estimates that ADSL service can reach 75 percent to 95 percent of U.S. phone customers without major upgrades. Kim Maxwell, a telecommunications industry analyst and chairman of the ADSL Forum, estimates that 15 percent to 20 percent of the phone network is blighted with loading coils, let alone other problems.

Even under ideal conditions, ADSL throughput depends on the length of the local loop. The maximum electrical resistance an ADSL signal can overcome is about 1500 ohms, which translates into 15,000 feet of 26-gauge twisted-pair copper wire or 18,000 feet of 24-gauge wire, which is larger. At that distance, ADSL can deliver about 1.544 Mbps downstream and 16 Kbps upstream. (Note the approximate 10-to-1 downstream/upstream ratio.) The ADSL Forum estimates that 80 percent of the phone customers in the U.S. are on local loops of 18,000 feet or less. In some countries, loops are shorter and nearly everyone is within 18,000 feet. That's good enough for downstream ADSL that matches T1 service.

As the loop gets shorter, attenuation decreases and throughput rapidly increases. At 16,000 feet, ADSL can deliver 2.048 Mbps downstream. At 12,000 feet, it's 6.312 Mbps. And at 9000 feet—the average line length for most U.S. customers, according to Maxwell—ADSL can deliver its nominal maximum speed of 8.448 Mbps downstream and 640 Kbps upstream.

Again, these rates assume a clean connection, which is rarely the case. ADSL modems use frequency-division multiplexing (FDM) or echo cancellation to make the most of that noisy pipe. After splitting off a 4-kHz band for POTS, they divide the higher-frequency region into upstream and downstream data paths. One ADSL standard, which is known as discrete multitone (DMT), allocates 255 subchannels about 4 kHz wide and then modulates a separate signal on each subchannel. Each signal encodes the data using quadrature amplitude modulation (QAM). This prevents noise in one subchannel from completely disrupting the connection. It also lets the modems dynamically adjust their data rates to compensate for line noise.

Cross-coupled interference is largely to blame for the asymmetry of ADSL. A phone line is not a continuous, unbroken pair of wires that runs from a central office to your home or workplace. The huge cables from a central office might bundle hundreds or even thousands of pairs together. As these cables spread out through neighborhoods, they funnel down to 50-pair cables and finally to the single pair that reaches your phone jack.

Bellcore estimates that a typical U.S. phone line crosses 22 splices during that journey. If ADSL modems tried to send high-speed signals in both directions, the line noise and cross talk within the 50-pair cables would significantly reduce their effective data rates. Asymmetric data paths are therefore a compromise that leverages bandwidth and extends ADSL service to more potential customers.

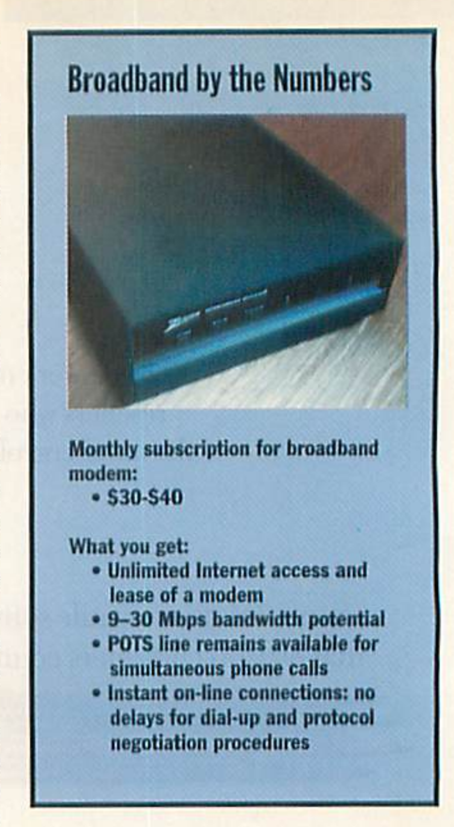
The result is that the existing phone network drains enough performance from ADSL modems to produce a wide gap between the theoretical and real-world speeds.

Cable Problems

Cable modems are dogged by legacy problems, too. The cablecos originally designed their networks to carry analog TV programming from a central head-end to homes. Coaxial cable has more inherent bandwidth than twisted-pair copper, but cable TV networks are handicapped by an unswitched tree-and-branch topology that was never intended for two-way or point-to-point communications. They also suffer from unterminated connectors, cheap splitters, amateur-installed wiring, a scarcity of the two-way amplifiers required for bidirectional transmission, and high susceptibility to RF interference.

The lack of sophisticated switching puts cable networks at a disadvantage for some modem applications. "Cable modems assume the whole world is IP, that everything you need is on the Internet," says Tom Ransom, director of corporate communications at Cardinal Technologies (Lancaster, PA), which makes ISDN modems. Cable modems may bring lightning-speed Internet access to consumers, but business customers may feel shortchanged. "There's no point-to-point communication, and we find that many people still need access to computers at remote locations," Ransom says.

Broadband by the Numbers



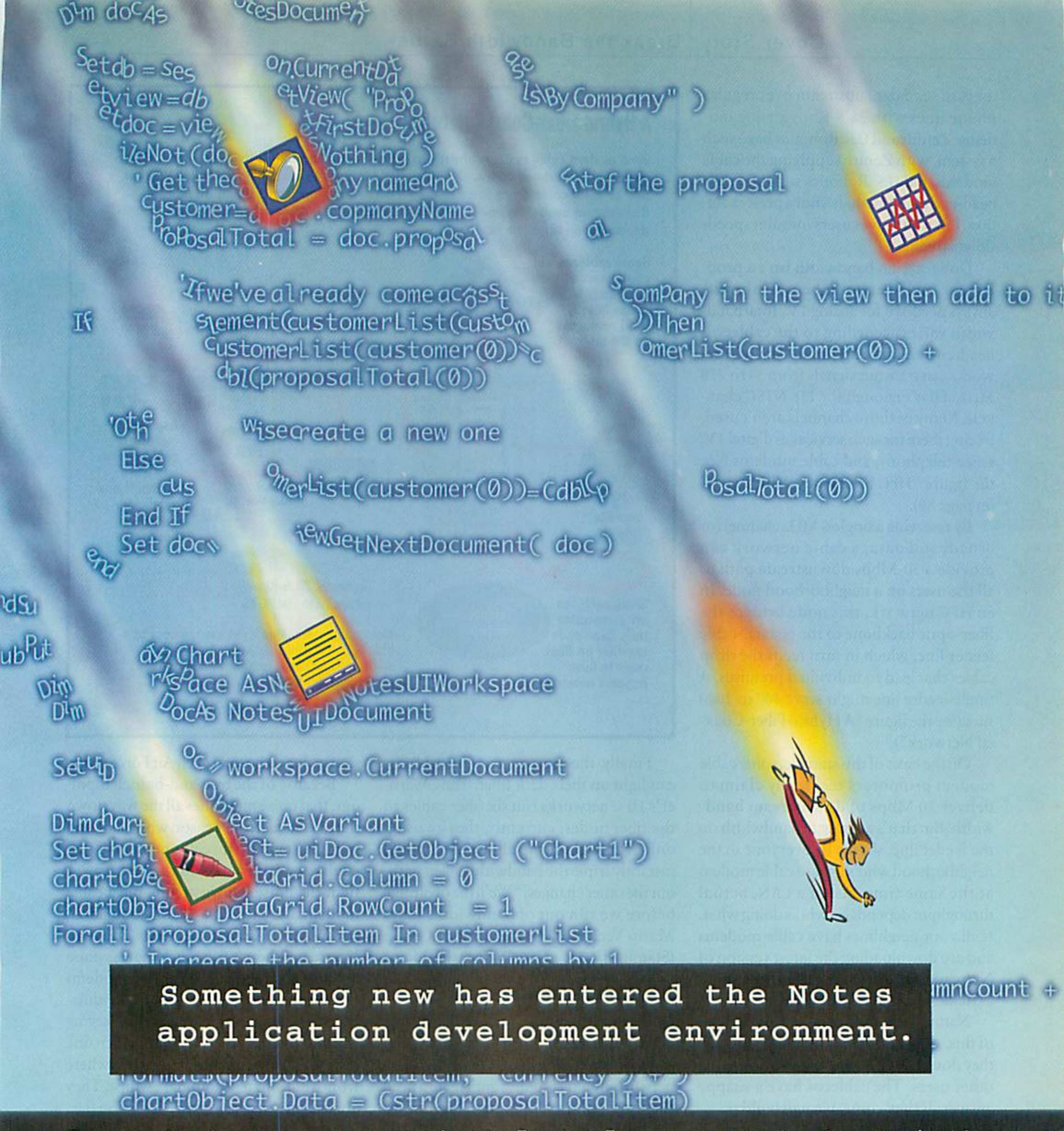
Monthly subscription for broadband modem:
- **$30-$40**

What you get:
- **Unlimited Internet access and lease of a modem**
- **9–30 Mbps bandwidth potential**
- **POTS line remains available for simultaneous phone calls**
- **Instant on-line connections: no delays for dial-up and protocol negotiation procedures**

Estimates of how many cable networks in the U.S. are capable of two-way broadband data service range all over the ballpark. At the low end, some analysts say only 5 percent of the cable infrastructure can deliver broadband service without upgrades. At the high end, Goldman Sachs estimates that 40 percent of Time Warner's networks are two-way-capable. Bruce Ravenel, president and CEO of TCI Internet Services, says 15 percent of U.S. cable networks are ready for broadband modems, and he predicts that this will grow to 30 percent or 35 percent by the end of 1997.

One thing is certain: The cablecos are investing billions in upgrades. They have to, if they want to survive in the new competitive climate fostered by the U.S. Telecommunications Act of 1996. Deregulation lets the telcos deliver local data services and even TV programming. It also lets the cablecos deliver local voice telephony, which—like broadband data—requires two-way capability and better switching. Time Warner Cable is spending at least $4 billion to upgrade its networks to hybrid fiber-coaxial (HFC) standards, and other cablecos are also investing large sums of money.

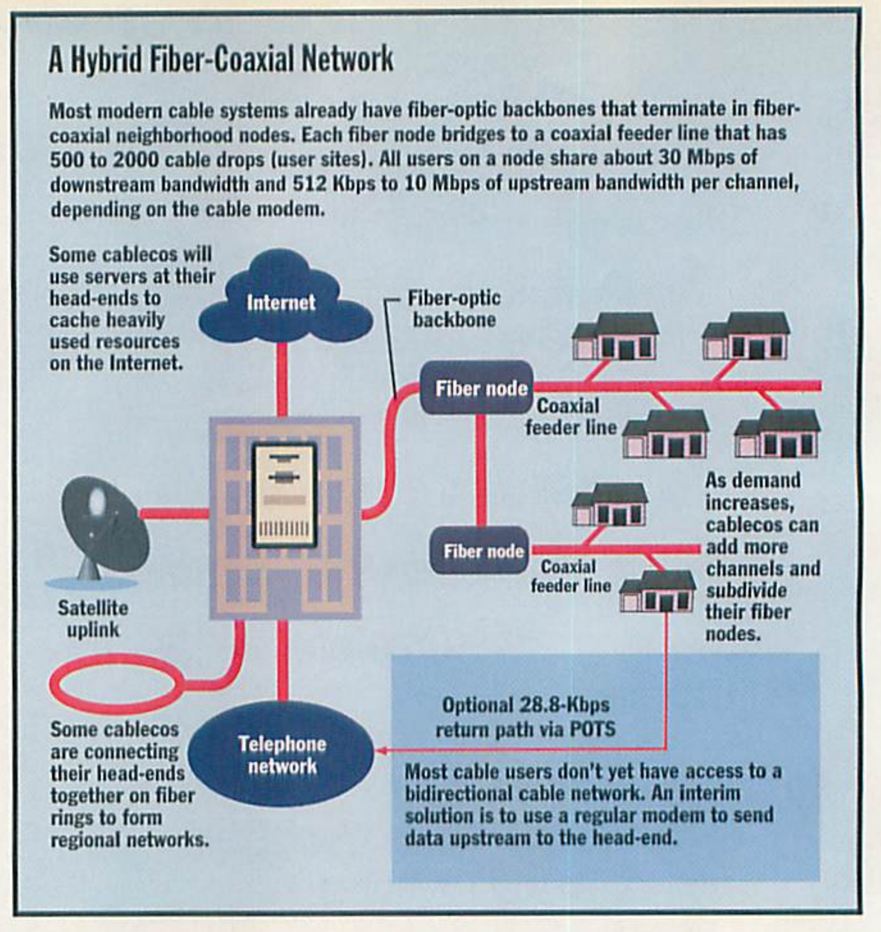
As a stopgap solution, some cablecos whose networks aren't ready for two-way communications will require cable modem


Something new has entered the Notes application development environment.

users to send data upstream over regular phone lines with 28.8-Kbps analog modems. Zenith and U.S. Robotics have such a system, with Zenith supplying the cable modems and U.S. Robotics supplying the head-end equipment. It's not a pretty solution, but it still gives users megabit speeds downstream.

Downstream bandwidth isn't a problem for cable networks because they've always needed it for analog TV. Total bandwidth varies according to the cableco's head-end equipment, but most HFC networks can transmit signals from 54 to 750 MHz. That's enough for 116 NTSC channels. Many of those channels aren't used, freeing them for such services as digital TV, voice telephony, and cable modems (see the figure "HFC Frequency Allocations" on page 80).

By reserving a single 6-MHz channel for broadband data, a cable network can provide a 30-Mbps downstream path to all the users on a neighborhood node. In an HFC network, this node bridges the fiber-optic backbone to the coaxial-cable feeder line, which in turn feeds the drop cables that lead to individual premises. A single feeder line might serve 500 to 2000 sites (see the figure "A Hybrid Fiber-Coaxial Network").



A Hybrid Fiber-Coaxial Network

Most modern cable systems already have fiber-optic backbones that terminate in fiber-coaxial neighborhood nodes. Each fiber node bridges to a coaxial feeder line that has 500 to 2000 cable drops (user sites). All users on a node share about 30 Mbps of downstream bandwidth and 512 Kbps to 10 Mbps of upstream bandwidth per channel, depending on the cable modem.

On the basis of this statistic, some cable modem promoters recklessly claim to deliver 30 Mbps of downstream bandwidth. But that's aggregate bandwidth on the feeder line, shared by everyone in the neighborhood who's using a cable modem at the same time. As on a LAN, actual throughput depends on who's doing what. If all your neighbors have cable modems and are downloading the latest version of Netscape Navigator, you'll be lucky to get a trickle of leftover bandwidth.

Naturally, the telcos make a big deal out of this. ADSL modems use phone lines, so they don't have to share bandwidth among other users. The cablecos have a snappy answer: If they come, we will build it.

To start with, it's not clear how much demand there will be for cable modems—30 Mbps might be plenty for a typical neighborhood. If it isn't, one option is to subdivide the fiber nodes, creating neighborhood subnetworks with as few as 125 customers on a 30-Mbps feeder line. Another option is to allocate additional 6-MHz channels to data services. Modern HFC networks can do this at the node level, assigning the same channel to multiple nodes throughout a network.

Finally, the most up-to-date cablecos can light up their dark fiber. Time Warner's HFC networks run six fiber cables to the fiber nodes; currently, they're using only two. Lighting up all the fiber would instantly triple the bandwidth, even without the other changes. "We'll die of old age before we run out of bandwidth," says Mario Vecchi, CTO of Excalibur Group (Stamford, CT), a Time Warner subsidiary.

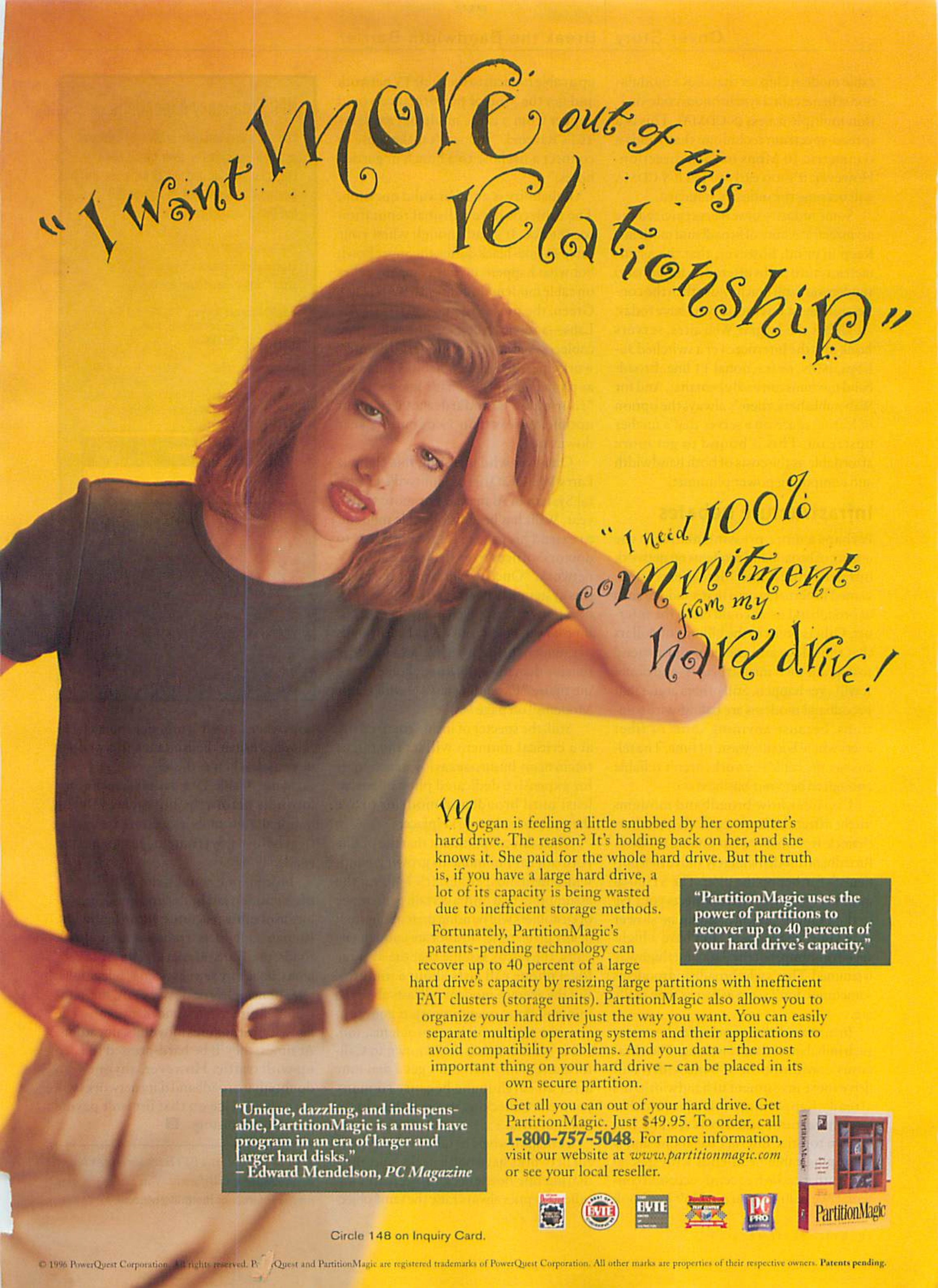
Asymmetric Again

Unfortunately, the upstream paths in cable networks aren't as well endowed as the downstream paths. Because the original network architects didn't anticipate a need for equal bandwidth in both directions, the upstream path from the user to the head-end is limited to a frequency range of 5 to 42 MHz. This region falls just below the lowest cable TV channels, and its primary purpose was simple pay-per-view signaling. Now it has to serve as the return path for interactive TV, voice telephony, and cable modems. Worse than that, it's the junkyard of the RF spectrum. Those frequencies are extremely vulnerable to ingress noise from unterminated connectors, bad wiring, household appliances, shortwave radio, and even Air Force radar.

Because of the tree-and-branch topology, that noise multiplies all the way down the line. In fact, one reason why there's no industry standard for cable modems is that engineers can't agree on the best way to fight the noise. Downstream, most cable modems use 64- or 256-QAM modulation, because it's fast and spectrally efficient. Upstream, there's too much ingress noise for either scheme. Thus, cable modems resort to slower but more robust modulation such as quadrature phase shift-keying (QPSK) or discrete wavelet multitone (DWMT). These methods yield anywhere from 512 Kbps to a nominal 4 Mbps. They also require forward error correction (i.e., Reed-Solomon or Viterbi), which consumes about 10 percent overhead.

As with ADSL, the result is an asymmetric data path—much more bandwidth downstream than upstream. Some cable modems are symmetric, but they usually do it by limiting the downstream bandwidth. Time Warner experimented with moving the return path to the gigahertz region, but it's too expensive for most cablecos.

Terayon (Santa Clara, CA) makes a


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cable modem chip set that uses a modulation scheme called synchronous code-division multiple access (S-CDMA). This is a spread-spectrum technique that yields a symmetric 10 Mbps in each direction. However, it's too early to tell if S-CDMA will become the industry standard.

Some industry observers criticized the asymmetric nature of broadband modems. Keep in mind, however, that the asymmetric return paths offered by broadband modems are still much wider than the connections most Internet servers have today. At all but the largest Web sites, servers hook into the Internet over a switched 56-Kbps, ISDN, or fractional T1 line. Broadband modems can easily beat that. And for Web publishers, there's always the option of leasing space on a server that's further upstream. This is bound to get more affordable as the costs of both bandwidth and computing power plummet.

Infrastructure Debates

Perhaps a more pressing matter is the impact of broadband modems on network infrastructures. Bob Metcalfe, who invented Ethernet, warns that a sudden rush of broadband users could crash the Internet. Others point to the billions of dollars that the telcos and cablecos must spend to upgrade their infrastructures and doubt it will ever happen. Still others argue that broadband modems are baling-wire solutions, because anything short of fiber everywhere is a silly waste of time. The telcos say the cable networks aren't reliable enough to bet your business on.

Consider how broadband modems might affect the Internet. Today, the bottleneck is probably your analog modem. Broadband modems merely shove that bottleneck further up the pipe. The $1500-a-month T1/DS1 line that connects your ISP to the point of presence might be slower than your new modem. You have a high-speed on-ramp, but the data superhighway is jammed. That's why broadband modems sometimes don't seem as fast as they really are.

In market-driven economies, however, such imbalances don't last long. The voracious consumption of bandwidth will drive more investment in bandwidth. It's already happening: @Home, a cable modem venture backed by TCI, is building its own top-tier Internet backbone and is equipping cable head-ends with special servers that cache frequently accessed content. "We realized you couldn't just hook up a cable modem to the cable TV network and get the kind of performance you'd expect from a cable modem," explains TCI's Ravenel. "It doesn't make sense to connect a firehose to a bunch of garden hoses."

Reliability is another valid question. The cablecos have a dismal reputation for service. It's bad enough when your cable TV goes black during the Super Bowl, but what happens if your company relies on cable modems to connect a WAN? Dick Green, the president and CEO of CableLabs—a research consortium funded by cablecos—argues that modern HFC networks meet the same reliability standard as phone networks. That's known as the "four nines" standard: 99.99 percent uptime, or less than 53 minutes a year downtime.

One user who is testing this claim is Larry Walls, CIO of the Huntsville Hospital System in Alabama. For more than a year, Walls has been using cable modems to extend his private fiber-optic WAN to doctors' offices over the local cable TV network. "Once we shook out the bugs, this system has been really rock-solid," he reports. "I can't even remember the last time it went down, and we've had all kinds of thunderstorms. It's a heckuva lot more reliable than my ISDN line at home." (See the figure "Extending a WAN with Cable Modems" on page 68.)

Still, the specter of losing connectivity at a critical moment will let the telcos retain many businesses as loyal customers for expensive dedicated phone lines, at least until broadband modems prove themselves in the marketplace.

The cablecos point out that the phone network isn't immune to growing bandwidth demands, either. It's built on the assumption that only a certain percentage of customers will be using their phone lines at any given time. To allocate enough circuits, the telcos assume that the average local phone call lasts about 6 minutes. But the average modem call lasts about 60 minutes. If too many users start going online, the telcos will have problems, too. (This is a fact that is well known to Californians, who often can't get a dial tone after an earthquake because so many people are checking to see if their loved ones survived.)

Perhaps it's best to take the long view: All networks have bottlenecks, and eliminating one bottleneck only creates another. Skeptics always raise the same objections when infrastructure-dependent technologies are in their infancy. Telephones were useless before the telcos began stringing wires. Cable TV was only a backwater business before the big cablecos went national. Automobiles weren't very practical before governments began paving roads.

Indeed, one could write a fair history of civilization just by documenting the evolution of infrastructures: Incan highways, Roman aqueducts, transcontinental railroads, the Trans-Alaska pipeline, the Panama Canal, city sewer systems, telegraphs, telephones, electric power grids, the autobahns, the interstates, and many more. The latest infrastructures move bits, not atoms. At times, they'll be hard-pressed to keep up with traffic. However, anyone who doubts that broadband data networks will earn their place on that list isn't paying attention to history. B

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HFC Frequency Allocations

There is some variation in the way cablecos assign frequencies on their hybrid fiber-coaxial networks, and not all cablecos are equipped to broadcast as high as 750 MHz, but these assignments are typical.

54 to 750 MHz:
Downstream spectrum
(from cable head-end to users)

Applications: Analog TV, digital TV, cable modem reception, voice telephony reception.
Each 6-MHz NTSC band (8 MHz for PAL) can carry one analog video channel, five digital video channels, one 30-Mbps data stream shared by cable modems, or 384 digitized voice conversations.

Downstream
Upstream
50 250 500 750

5 to 42 MHz: Upstream spectrum
(from users to cable head-end)

Applications: Pay-per-view signaling, cable modem return, voice telephony return.
The 6-MHz bands at this end of the spectrum are much noisier and require more robust modulation schemes, which are not as spectrally efficient as the modulation schemes used downstream.

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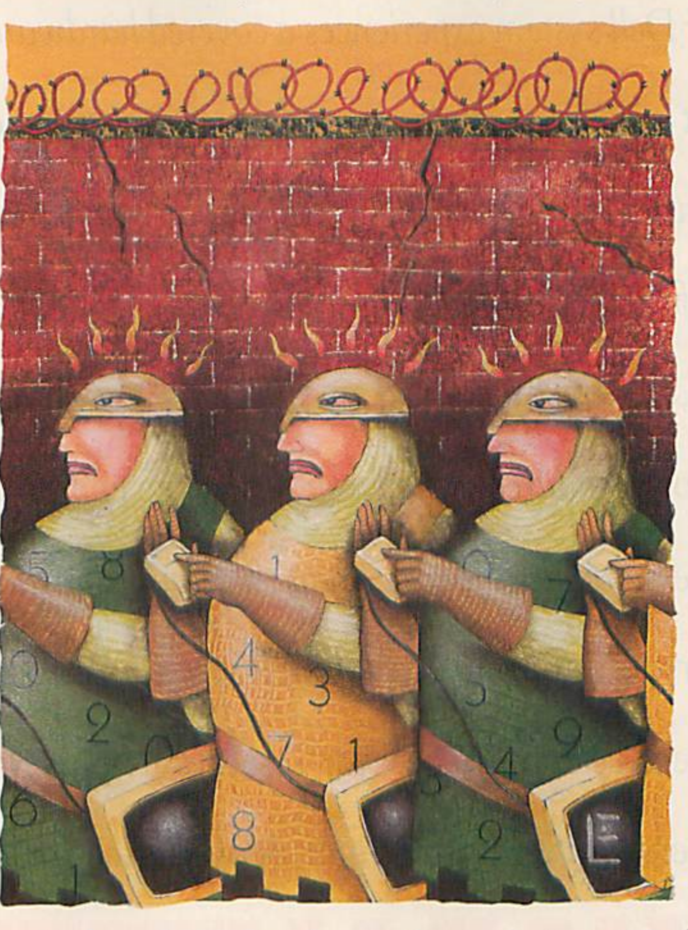
Barbarians at the Firewall

If you think firewalls are fail-safe protection against electronic intruders, think again.

By Deborah Kerr

The notion of a firewall as an impregnable defense against intruders is going up in smoke. Firewalls *were* in place in two highly publicized security breaches. One involved a break-in of security consultant Tsutomu Shimomura's system, which was chronicled in the book *Takedown*. The other was the penetration of several computers at the Los Alamos National Laboratory earlier this year. These aren't isolated cases. According to the Computer Security Institute, 30 percent of the Internet sites that reported breaches in their security had a firewall in operation.

The easiest way to circumvent a firewall is to outflank it, much as the Germans simply went around the "impregnable" Maginot Line to invade France in 1940. Organizations often spend tens of thousands of dollars on expensive firewalls or, in some cases, forgo Internet connectivity altogether, only to risk attack through dial-in-modem pools or other insecure access points (see the figure "Security Holes" on page 80NA 6). So, the first lesson to learn about firewalls is this: A firewall is only one component of a comprehensive security policy.



Here are some ways that you can choose the right firewall product for your firm, implement it within an overall strategy, and plug any remaining security holes.

Security vs. Convenience

Choosing the right security architecture involves inevitable trade-offs. In general, the more secure the firewall, the less transparent it becomes, and the less convenient it is for authorized users to pass through. To weigh the trade-offs, you must determine what constitutes an acceptable risk. Ask yourself, "How much damage can be done if my data is compromised or corrupted?" However, you shouldn't automatically discount the value of convenience. It could determine the success of Internet acceptance across your organization and may have some security consequences of its own. If Internet access becomes too cumbersome, savvy users will find other, less manageable, ways to connect to the Internet, usually through Internet service providers (ISPs) or on-line services.

On the low end of firewall security is *packet screening* (also known as *network-level firewalls* or *filtering gateways*), a mechanism that is usually handled at the router level. Consistent with TCP/IP, the router screens packet headers for source and destination addresses, and allows or denies entry based on rules that you develop to define allowable transmissions.

Network-level firewalls are low-security approaches, because they're vulnerable to hackers who break in by IP spoofing. In this breach, hackers disguise incoming packets to look as if they come from a trusted host, thus gaining entry because the router can't tell the difference between an authentic network address and a disguised one. Routers are insecure because they're essentially dumb boxes that were designed to enable the free flow of information, not to prevent data transmission.

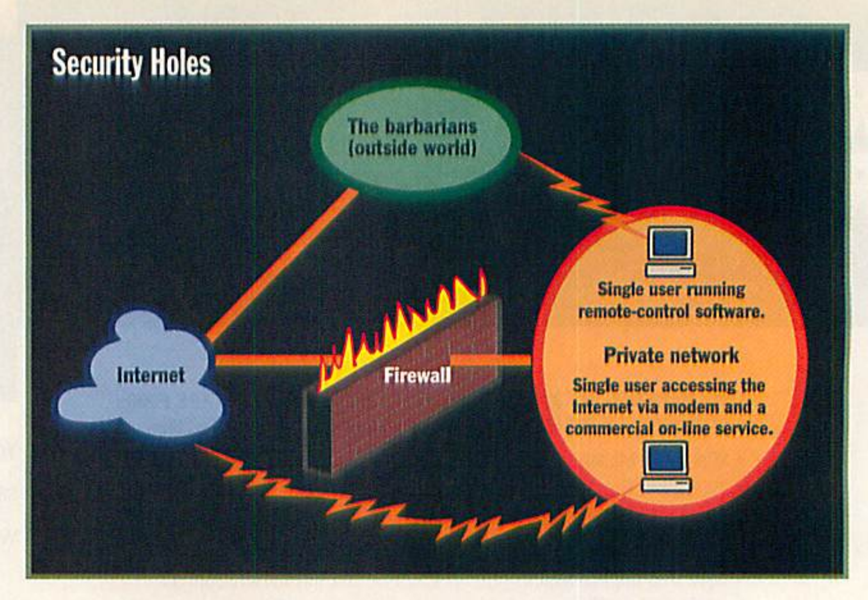
To improve security, you can place a host or an isolated subnetwork behind the screening router. The host sits on the private network, and the screening router allows access only to

this host. The screened host restricts entry points to the private network, so you can better audit, control, and fortify access by adding security measures to the single host. The screened host then becomes a choke point for monitoring data flow.

Internet by Proxy

Application-level firewalls go a step further than network-level packet screening. An application-level firewall sits between the private network and the Internet. It relays data between the two networks. Application programs, or proxies, run on the firewall gateway and enable specific software services, such as e-mail, SNMP, or FTP. Proxies can perform sophisticated functions such as logging or user authentication, and because they are built to monitor specific protocols, proxies can enforce customized security options (e.g., allowing incoming FTP while blocking outgoing FTP).

However, even application-level firewalls are vulnerable. FTP and other Internet protocols can leave the system without a security check, thus exposing a network to attack from the inside. Application-level firewalls can also let pass Trojan-horse programs or macro files, two variations of rogue programs that hide inside authorized programs. These programs execute as soon as they are opened or read. Besides causing direct damage to your system, embedded programs might look for a well-known host table and mail data and password lists to another address.



A security policy that's too restrictive may encourage employees to open up entry points around a firewall.

Proxy servers present management headaches, according to Kevin Kitagawa, Internet security product line manager for Sun's Internet Commerce Group. "Proxy servers are wonderful for most common Internet protocols or services," he says. "The problem is, for every new protocol or service that comes out, you have to add another application to the proxy server, like screening audio and so on." The proxy server cannot handle protocols that lack a specific proxy for them. Proxy architectures can also degrade performance and transparency.

A *dual-homed* gateway represents the highest level of firewall security. A host system sits on both the private network and the Internet. TCP/IP forwarding is disabled, fully isolating the two networks. You supply access by configuring application proxies or by granting user log-ins to the gateway host.

If you choose to implement proxies for access, you face the same shortcomings inherent to proxy servers (i.e., requiring a proxy for each supported service). If, instead, you grant access to the gateway host, you risk compromising the entire private network if the gateway password is compromised.

Several commercial firewall products provide turnkey ways to install a firewall in your organization. No matter which level of firewall security you choose, the product you buy or create should offer some minimum capabilities (see the text box "Firewall Checklist").

A good firewall should incorporate a set of peripheral security systems to protect such things as e-mail transfers and provide for data integrity through password protection and encryption capabilities. These peripheral systems should perform five key functions:

- Authentication (on an individual, computer, network, or subnetwork basis).
- Access control.
- Encryption: Encoding transferred data

Firewall Checklist

In a comprehensive report financed by the National Institute of Standards and Technology, authors John Wack and Lisa Carnahan recommend looking for firewalls with the following elements:

- ✔ Strong filtering techniques that support a "deny all services except those specifically permitted" policy, based on attributes such as source and destination IP address, protocol type, source and destination ports, and inbound/outbound interfaces.
- ✔ Easy configuration to support your basic security policy.
- ✔ Flexibility to accommodate new services and needs as the security policy and organizational structure change.
- ✔ Proxy services to implement advanced authentication measures (e.g., digital-signature certificates or public-key cryptography) and centralize SMTP at a buffer zone between servers.
- ✔ Segregation of systems that don't require public access.
- ✔ Thorough logging and auditing tools for reporting suspicious activity.
- ✔ A secured version of the OS, such as Unix, in which all known security holes are already plugged.
- ✔ An interface that is easy to use and maintain, including an extensible architecture for patching new holes that might arise.

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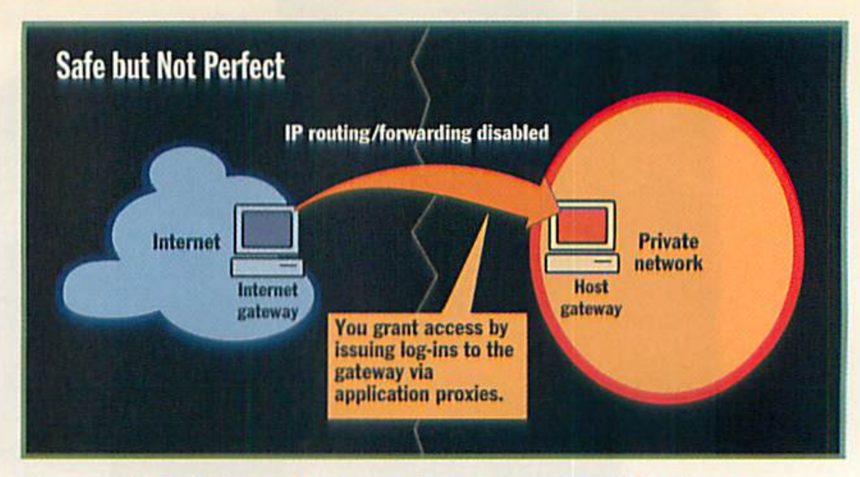
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that the intended recipient can deencrypt securely.

• Data integrity: Ensuring that information cannot be changed if it is intercepted.

• Nonrepudiation: Proof that a known entity generated a transaction, usually performed by digital signatures.



A dual-homed gateway boosts security with a host on both the private network and to the Internet.

A Firewall Isn't Enough

Checking for and plugging security holes is one of the final stages of a firewall security audit, according to Padgett Peterson, corporate information security engineer for Lockheed Martin. From his base office in Orlando, Peterson manages over 1000 WANs, from government installations and various partner companies to the WANs that support the 190,000 employees of Lockheed Martin.

Echoing other security experts, Peterson recommends that you begin a security audit by establishing a comprehensive network security policy. According to a survey done this year by the American Society for Industrial Security, only 51 percent of reporting companies had a written information-systems security policy. Yet, policy is the most crucial part of performing a security audit. It should define what information, computer resources, and corporate assets are most sensitive—in short, what needs protection and from whom.

You should set up a policy that controls employee passwords and teaches basic rules of password protection. For example, don't make passwords obvious, don't give out passwords over the phone, and don't leave them lying around or scribbled on Post-It notes. Michael Oke, a system software and security consultant, reports that a 12-year-old boy hacked a Southern California sales firm using just such a found password. He capitalized on a bug in SYSEDIT and downloaded an entire database after memorizing a password he saw stuck to the receptionist's terminal when tagging along on a delivery with an older sibling.

The second step in plugging security holes is to take a census of your company's electronic weak points. Know the inherent security holes in each computing platform that runs at your company. Then, on a node-by-node basis, check for human programming errors and locations where information may cross paths, such as e-mail and telnet transfer points, dial-in-modem ports, Web access points, or a Web server that's set up on the intranet.

Third, consider using a network security testing firm or a commercial security tool. One such firm is Internet Security Systems (Atlanta, GA). ISS developed a software tool that's called the Internet Scanner to search for network security breaches. The Internet Scanner goes over the network and applies the algorithms and techniques a hacker uses to see if there's a known weakness in the firewall or an individual host such as Unix.

The scanner looks for 130 known security holes on firewalls, routers, Unix, Windows, and Windows NT—any device that is accessible through TCP/IP. It runs on a variety of Unix variants, and the cost varies depending on the work load: $795 to scan 10 devices, $3995 for 100, and $19,995 for 1000.

Programs such as SATAN (System Administrator's Tool for Analyzing Networks) also scan Unix-based machines for typical entry points. They are available for free off the Internet (search for keyword "SATAN") but require a fairly technical security auditor to direct and read them.

The last step in a comprehensive security audit is to create a report of known weaknesses. It should answer several key questions, including how to secure access and monitor the bidirectional flow of data, whom your company should allow access rights to, how up to date are your current security mechanisms, how much will the security system cost, and how much is the data worth in relation to the overall expense?

Peterson recommends performing audits and updating system security policy once a year or when a major change in corporate structure takes place.

Due Diligence

Ultimately, firewalls are not impenetrable. The good news is that the firewall market is still maturing. Modern commercial firewalls take security to the next level by combining the best elements of past firewall developments and teaming them with encryption, user authentication, digital signatures, and management software to further tighten gateway security. The best software-driven devices are fully configurable with comprehensive, single-point management and reporting capabilities administered from a standalone terminal that talks to the firewall. Firewalls are increasingly used to buffer corporate intranets not only from the Internet, but from each other.

After you install a state-of-the-art firewall, don't get complacent, warns Oke. "The main reason firewalls don't work is because people put too much dependence on them. They open holes that may or may not have been there before they installed the firewall," he says.

The best firewall won't prevent breaches caused by obvious passwords, passwords carelessly given to unauthorized persons, or insecure dial-in modems. Remember the Maginot Line. No doubt it was impressive, but all you had to do was walk around it. ■

Deborah Kerr is a freelance writer based in northern California who specializes in Internet commerce and related security issues. You can reach her at **dkerr@aol.com**.

Control Quality

New tools and strategies can simplify, automate, and generally reduce the stress of achieving quality in client/server applications.
By Edmund X. DeJesus

The challenges of writing high-quality software for client/server applications are bigger—and stranger—than for simple one-machine/one-user jobs. You probably have multiple hardware platforms and OSes. End users will probably work on LANs and WANs strung tenuously together all over the planet. The allegedly "new" application probably must have its fingers in existing legacy-software pies.

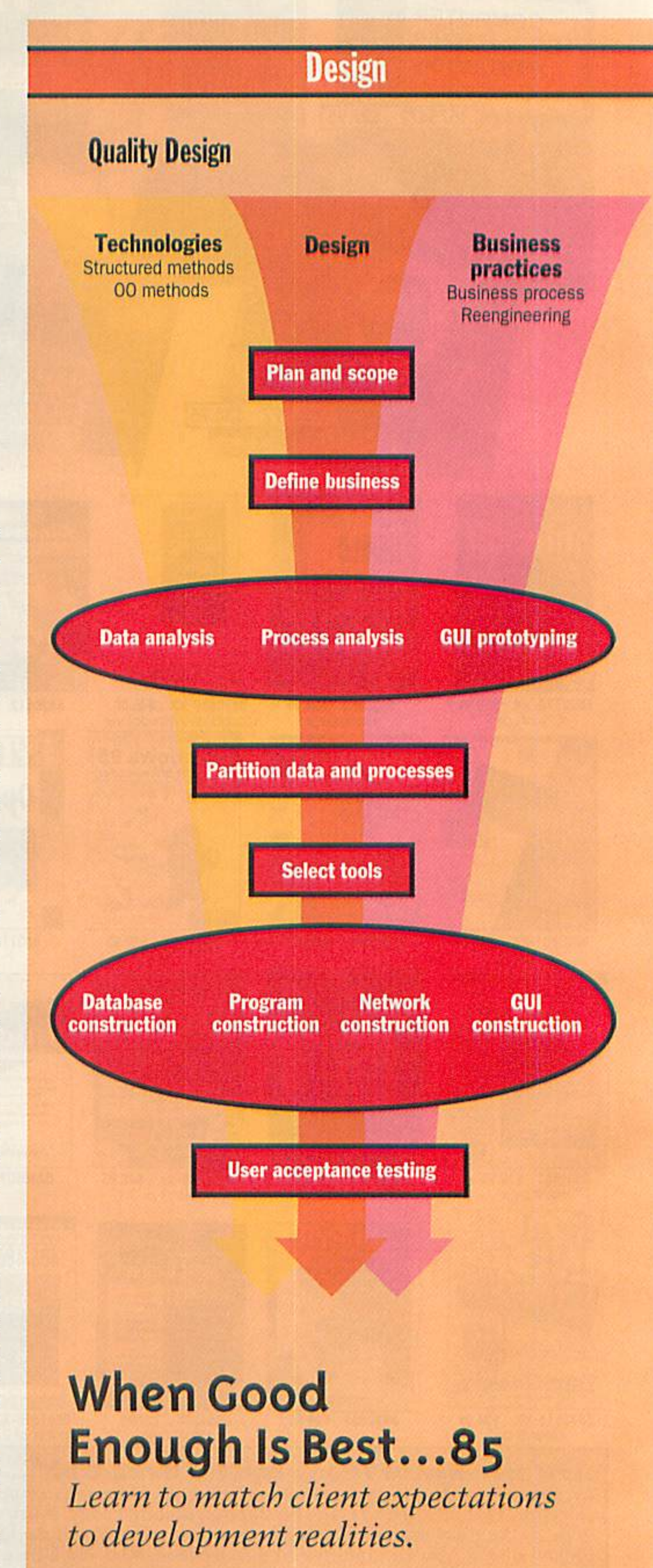
Hey, don't quit yet! The general principles that apply to producing quality code in the simplest situations are just as valuable in the client/server arena. You have to get realistic specifications for what the application will do. You have to develop realistic plans for the development process that will promote software quality. Testing and verification will be sensible, rigorous, and ongoing. The customary prayer wouldn't hurt, either.

Still, the client/server angles can blindside you. Imagine how the complex specifications are going to change along the way—especially as the platform issues influence what is (im)possible. Your development teams may be on different continents. How are you going to coordinate all this? Are you going to find tools that deal with the resulting complexity, or are you going to write your own? And the very notion of testing all this will probably cause you to wake up screaming at 3:00 a.m.

Take a deep breath. Your first step will be the specification and design of client/server applications. The good news is that the computing world is finally awakening to what you've known all along: You can't do everything asked for on time and in budget. We'll show you the realistic alternative and illustrate how the design phase should become an ongoing process in your project.

More good news: Development tools and middleware can smooth over some of the cross-platform cracks. Coordinating your far-flung collaborators is not the nightmare you've dreaded, either. Products that track and route all the pieces ease the strain considerably. The best news may be testers. Testing is now often best done automatically. These robot-like examiners can simulate umpteen-thousand users slamming away at your application. Actual use will seem dull compared to what these self-propelled nitpickers do.

Maybe software quality for client/server applications doesn't drop like the gentle rain from heaven. However, this information will keep you from being washed away in a torrent of complexity and broken code.



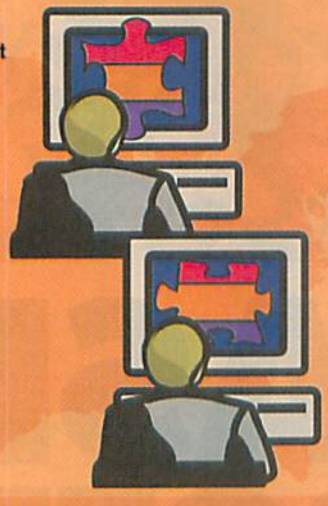
When Good Enough Is Best...85

Learn to match client expectations to development realities.

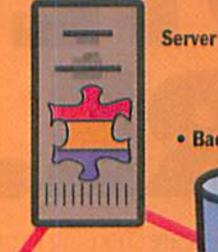
Development → **Testing**

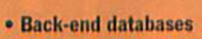
Quality Development

Distributed development
- Harmonize development and test
- Code coverage
- Distributed management tools

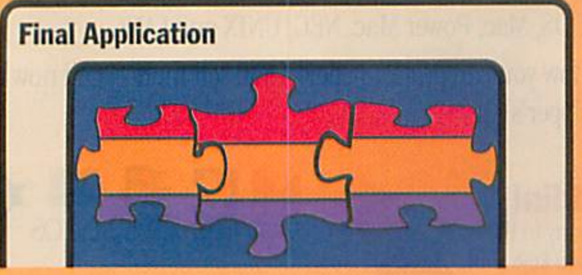
Distributed Application









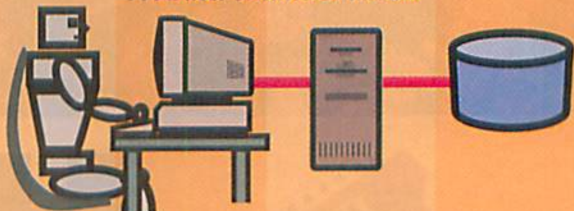


Quality Testing

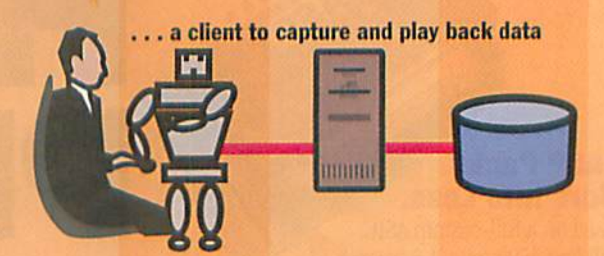
User | Client | Server | Database

Automated testing can simulate . . .

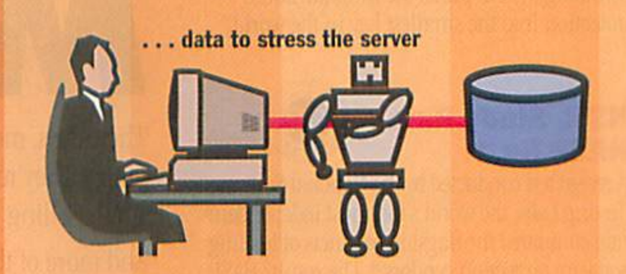
. . . a user to exercise the GUI



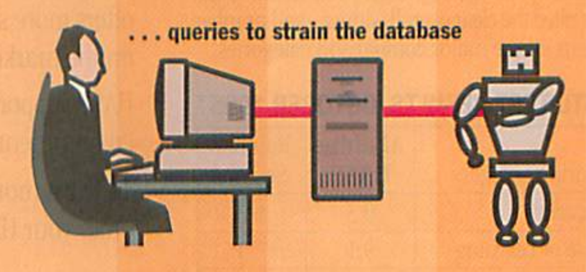
. . . a client to capture and play back data



. . . data to stress the server



. . . queries to strain the database



Developing Quality...93

A handful of tools and management techniques help with distributed development.

Testing, Testing...97

Both shrink-wrapped and custom tools can take on your testing duties.

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Ease of Learning	9.1	7.1
Ease of Use	8.3	7.2
Versatility/Features	10	8.7
Compatibility	6.7	6.5
Speed of API Calls	0.9	1.2
Final Score	**8.5**	6.5

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The design for your client/server systems should be a realistic—and ongoing—process. By Edward Yourdon

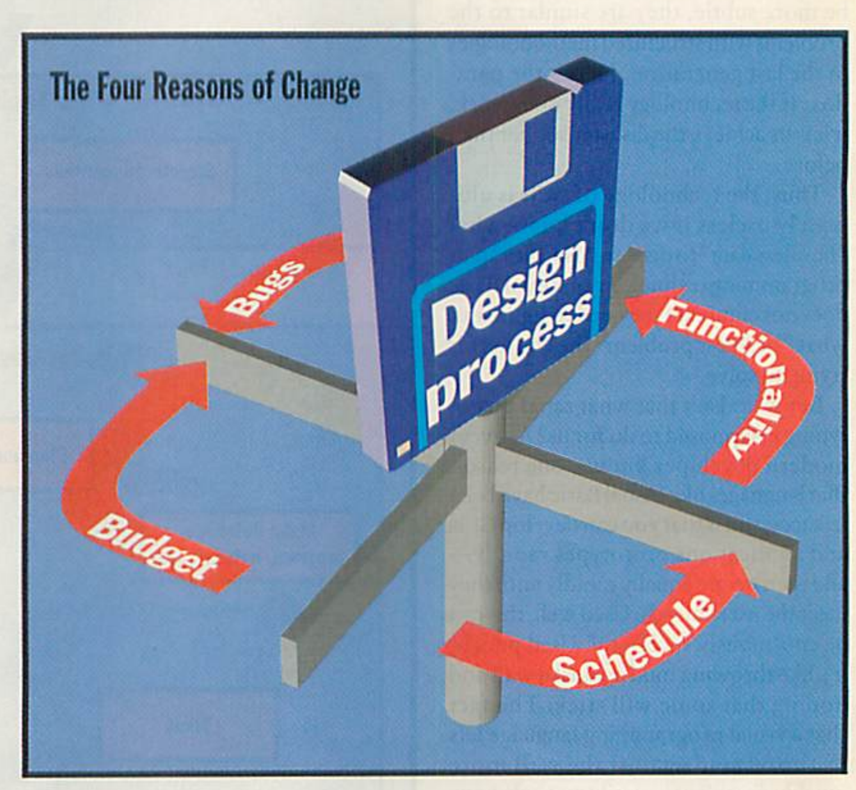
When Good Enough Is Best

Could it be that we're striving for too much quality in our client/server systems? A recent survey by the Standish Group reports that the typical client/server project is 50 percent over budget and 50 percent behind schedule. Things really appear gloomy when you consider that we've been hearing statistics like this for over 20 years. After a generation of trying to use traditional software engineering principles, these sad statistics point to two possible explanations: We're hopelessly incompetent at writing high-quality software, or end users are hopelessly demanding.

The second possibility may be explained by business pressures that encourage software end users to impose more stringent demands on software developers—even though, deep in their hearts, end users know that with the finite resources they're providing the project team, they'll never be able to get the full extent of functionality, schedule, cost, and defect levels they're after. Meanwhile, software developers are still laboring under the delusion that end users *can* have it all, and it's just a matter of finding the ideal tools and processes to accomplish development miracles.

How do you handle these problems when you sit down to design a client/server application? If you can't offer end users miracles, give them a pragmatic alternative: good-enough software. Now the mantra of Silicon Valley software developers, this concept strikes a practical and realistic compromise among the elements that go into our traditional definition of software quality: zero defects, on-time schedules, in-budget costs, and end-user-requested features.

Here are some reasons why your next client/server application might be better off if it's just good enough.



Budget, schedule, functions, and defects all affect the design—mandating an ongoing design process.

Software Quality

We need to readjust our view of software quality. Our traditional definition has become elusive in the client/server world, especially now that client/server includes entities like intranets and Java. Software developers have typically used the word *quality* to describe a bug-free system that meets the user's requirements and is delivered on time and within budget. In reality, it's a word that describes few actual systems. As we'll see, the very definition of quality is the decisive factor in designing client/server systems successfully.

The three main ingredients for delivering this form of quality are people, technology, and processes. The people ingredient is crucial—and obvious. An organization with mediocre programmers is not going to create high-quality systems, no matter what language they write their code in.

The second ingredient—technology—is where most software developers concentrate their efforts. That's no big surprise, considering it's where client/server systems achieved their first great triumph over mainframe systems. The technology of intelligent workstations and GUIs provides end users with higher-quality systems than dumb-terminal, character-based mainframes. The technology of visual, RAD-oriented (rapid application development) environments—Visual Basic, Delphi, PowerBuilder, and others—helps us build systems faster than we could in the COBOL and mainframe days.

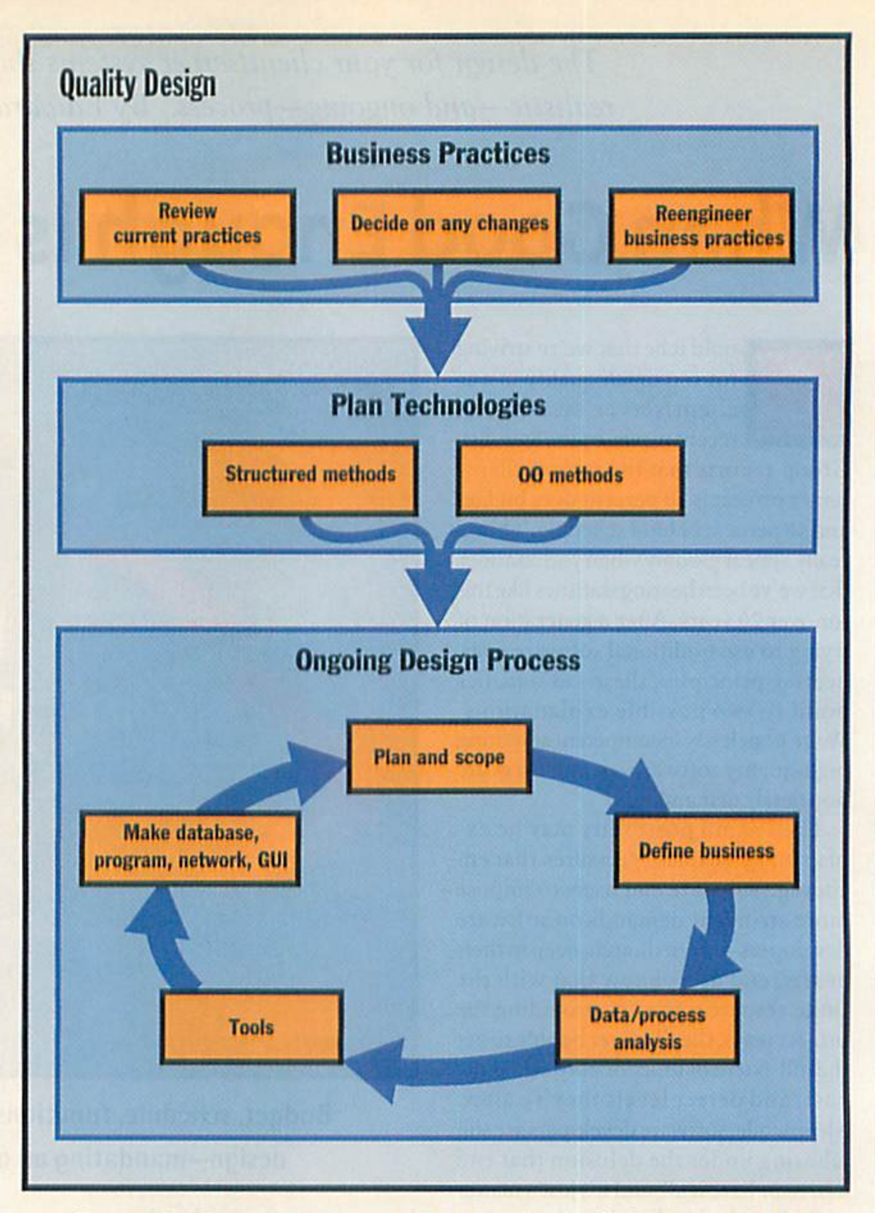
Alongside these technological improvements, we also encountered some new problems. For instance, client/server technology typically involves open systems, which means that developers face a heterogeneous mix of hardware

platforms, OSes, middleware, DBMS packages, languages, and protocols. It's all supposed to work together, but it's usually more complicated than in the days of closed, proprietary environments. And when something goes wrong, every open-systems vendor points a finger at someone else.

While the technology problems may be more subtle, they are similar to the problems with structured methodologies in the last generation. Here's the paradox: If the technology really does work, it lets us achieve the disaster sooner than before.

Thus, the technology of GUIs is ultimately useless if we don't know what "business data" to display. Also, the rapid-programming technology of Visual Basic does not eliminate the need to figure out what "business problem" the end user is trying to solve.

But wait. Isn't that what rapid prototyping is supposed to do for us? As every modern developer knows, one reason that languages like Visual Basic have been so successful is that you can develop GUIs and applications prototypes rapidly—and then iterate equally rapidly until they meet the user's needs. Used well, this can be enormously successful. Used poorly, it's like throwing mud against a wall and hoping that some will stick. The fact that a visual programming language lets us throw mud against the wall more quickly doesn't necessarily mean that any more of it is going to stick.



Expect business practices and technologies (which may both be changing) to affect the ongoing design process.

It's the Process, Stupid

In any case, what's really going on here is the use of technology to support a process. Such processes have names like prototyping, spiral development, or RAD. As our client/server projects have begun to scale up in size and complexity, we've learned that it helps to pay closer attention to the details of the process before we simply let our admittedly good technology start throwing mud against the wall. A good example of a client/server development process is the one recommended by consultant Lou Russell (see the figure "Quality Design" in the article "Control Quality" on page 82).

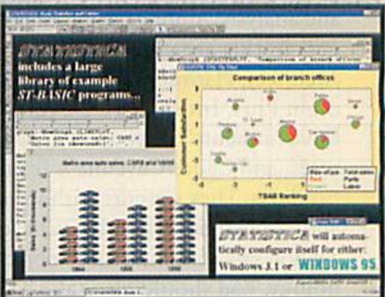
The initial activities of business reengineering, defining business events, and documenting the analysis requirements will likely determine the real success of the client/server project. Given the pressures found in today's business environments, you have to carry out these activities relatively quickly—but you *do* have to carry them out. No one can afford to spend five years drawing data-flow and entity-relationship diagrams the way we did in the 1970s. You probably won't even have five months. But it might well be worth spending five weeks, and, unless it's a trivial project, it's usually worth spending at least five days on these initial activities.

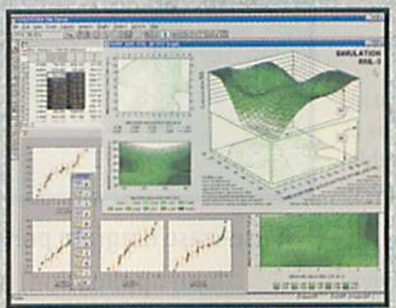
However, we can't perform this analysis activity only once, as we did with our old waterfall life-cycle processes. We must be prepared to carry out the analysis activity (along with all the other activities in the client/server development figure) repeatedly, for each deliverable "version" of the system.

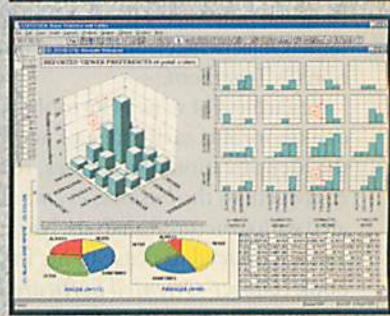
Unfortunately, the structured analysis/design methodologies from the 1970s were often associated with sequential, waterfall development processes—and thus many developers rejected them as they embraced the iterative processes associated with client/server projects. Even without this problem, however, there has been a steady movement toward object-oriented (OO) methodologies. Object technology is usually more appropriate for building the GUIs that dominate many of today's client/server systems. Furthermore, object technology is usually a better foundation

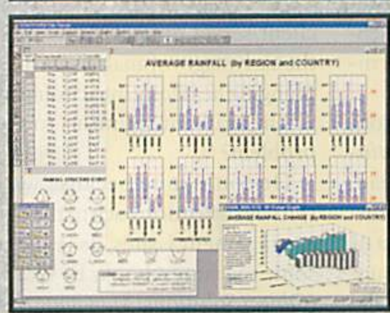
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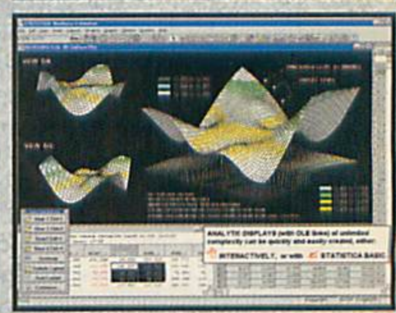


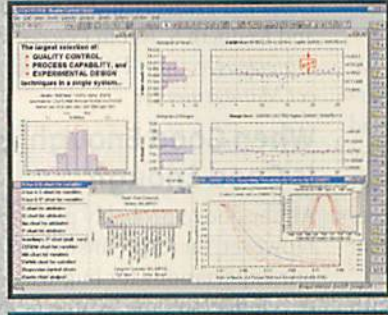


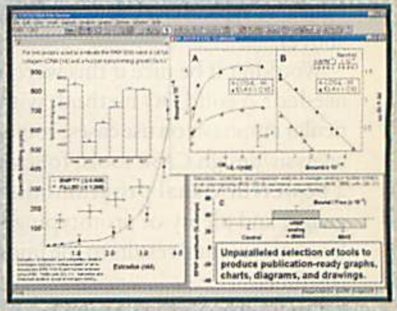


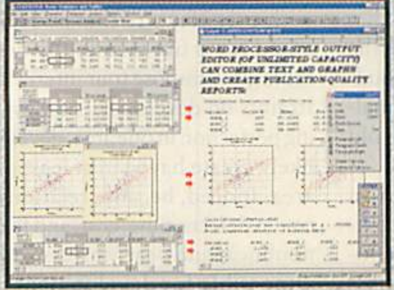


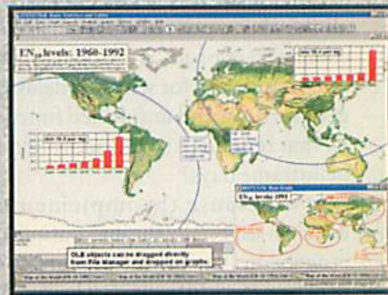












for reuse (which is another important technology for improving productivity and quality).

This last remark deserves emphasis: Technology can support, and ultimately automate, many processes. Thus, we should look for technology to support the early activities of business reengineering and analysis. Among the excellent products in this area are Popkin's System Architect, Platinum Technology's Paradigm Plus, Interactive Development Environments' Software Through Pictures, and Cadre/Cayenne's TeamWork products. They support both structured and OO methodologies. If you have made a wholesale commitment to object technology, you should also take a look at Rational Software's Rose, Mark V Systems' ObjectMaker, and Object International's Together/C++.

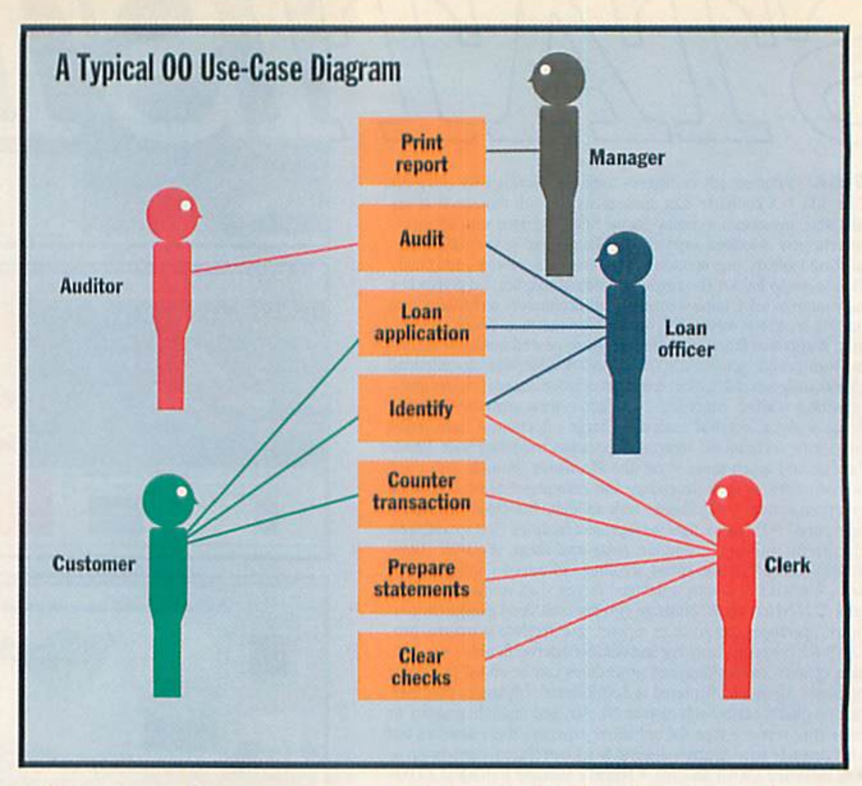
Regardless of which OO tool you use, one important early stage of analysis is the identification of *use cases*, roughly equivalent to the *business events* associated with structured analysis. Ivar Jacobson introduced use case in his first OO book (*Object-Oriented Software Engineering*). Several methodologists recommend use case for documenting the essential details of how the business user intends to interact with the system.

Several recent OO books (e.g., Jacobson's *The Object Advantage* and *Mainstream Objects* by Yourdon, Whitehead, Thomann, Oppel, and Nevermann) illustrate the use-case approach, and most of the popular OO analysis/design tools support the diagramming notation (see the figure "A Typical OO Use-Case Diagram" above).

Wouldn't it be nice if this were all we needed? A solid OO method, with particular emphasis on use cases; some good analysis/design CASE tools, followed by a powerful visual programming language; and plenty of prototyping to deliver incremental results to the impatient customer.

Obviously, this is not the case. With all the above procedures, why is it that client/server projects are developing the same reputation for schedule delays, budget overruns, and unfulfilled functionality that remind us so unfondly of the old mainframe days?

Is it because the implementation details—especially the integration of heterogeneous hardware/software components—are so difficult? Is it because most



A use-case diagram portrays roles (e.g., clerk) and activities (e.g., loan application) and the connections between them.

client/server project teams are skipping the early stages of analysis and design, and plunging headlong into coding, thus providing brilliant solutions to the wrong problem?

Or could it be because we need to shift our attention back to the people and management issues, as is suggested in some recent textbooks by Grady Booch (*Object Solutions: Managing the Object-Oriented Project*) and Adele Goldberg and Kenneth S. Rubin (*Succeeding With Objects: Decision Frameworks for Project Management*)?

When Good Enough Is Good Enough

All the above probably play some role. However, the larger answer may be that our expectations for bug-free software developed on time, within budget, and with every feature that end users have asked for is unrealistic. By definition, these goals impose four interrelated constraints on developers, and by attempting perfection in one area, developers will likely create havoc in at least one other area. Indeed, because relationships between defects, time, cost, and features are nonlinear and nearly inverse, it's almost impossible for development teams to intuitively predict, say, the impact of a scheduling crunch on cost, defects, and features.

That's why just producing an up-front specification for good-enough software isn't enough. You and your end users must engage in a *dynamic* reevaluation of the specification, because most development projects take place in what author James Bach justly calls a "mad world." On a daily basis, the project team may find that the hardware has changed, the tool vendors have changed (some bankrupt, others brand new), government regulations have changed, the economy has changed, and the business risks have changed. Consequently, the user's requirements for the system change, and the design and implementation must change, too.

Of course, prototyping is entirely compatible with mad-world, good-enough software development. However, many development teams—with the best of intentions—start their projects with fixed front-end analysis/design processes, and with a built-in conviction (based on decades of tribal folklore) that all bugs are evil and that all requirements are doable, even within ridiculous schedule and budget constraints. The reality is that

some bugs are better than others (as suggested by the familiar term *showstopper*), and that our systems will go into production with known bugs that the project team has not been able to eliminate—as well as latent bugs that the project team isn't even aware of.

A realistic objective for nontrivial client/server projects in today's pressured business environment is that we will consciously choose which bugs will be in the product we ship. The consequences of this cold-blooded, good-enough approach are primarily evident in the latter stages of coding and testing, but they have strong implications in the earlier stages of a project, too.

Even more important in the early stages of a project is the concept of *triage*. Twenty years of cost and schedule overruns should tell us that our customers will ask for more than is reasonable and that we will not deliver it all. Rather than waiting until the day before the deadline to decide which parts of the system work and which don't, you should address this issue from the very beginning of the project.

The questions to ask the customer are these:

- Which requirements are essential (i.e., without them, the system can't be used at all)?
- Which requirements are important (i.e., without them, the system will be difficult or unpleasant to use)?
- Which requirements are optional (i.e., the "bells and whistles" that would make the system fun and interesting to use, but which aren't essential or even important)?

If the customer categorically decrees that all requirements are essential, you're doomed. It's likely that the project team will be late and over budget, even with good people, good tools, and good processes. If you can accomplish a rational triage, however, there's a good chance you'll finish the must-have features and perhaps even some of the should-have features. The could-have features may not even make it into the design phase of the project.

In today's mad world, we also have to reevaluate this triage on a daily basis. Yesterday's must-have requirement could become irrelevant if our user's strongest competitor suddenly goes bankrupt. Also, entirely new requirements can emerge at any point during the lifetime of the project. All this means that we have to focus more and more attention on *requirements management*, an activity that comes before the detailed analysis and design modeling handled by the tools described earlier.

The tools used for this activity are word processors, because users typically describe their requirements in imperative English sentences like "the system *must* do X, Y, and Z." Associated tools such as RTM (from Marconi Systems), Doors (from Zycad), and Requisite Pro (from Requisite) can help describe the priority, cost, risk, and other attributes of each requirement.

As the attributes change dynamically throughout the project, requirements management tools can help ensure that the team remains focused on the must-have features, without being distracted by the could-have features that should be sacrificed to deliver something that is good enough.

Acceptable Compromises

Good-enough software is a controversial concept. In fact, many traditional software engineers reject it as an apology for mediocrity. But realistically, all forms of engineering involve making explicit, rational compromises in a world of finite resources. The trick is to ensure that both the developer and the customer understand what those compromises are, and that they both agree that the result of these compromises are indeed good enough.

Visual programming languages may help us write more code more quickly than ever before. OO analysis/design methods and tools may help us understand the details of the user's requirements more clearly than before. However, if we are to achieve success in the complex world of client/server systems, we'll have to learn to apply triage to the requirements at the beginning—and throughout the life—of the project. ■

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Zycad Corp.
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Edward Yourdon, developer of the "Yourdon method" of structured systems analysis and design, and codeveloper of the Yourdon/Whitehead method of OO analysis and design, and the Coad/Yourdon OO methodology, is the author of over 200 technical articles and 22 computer books, including, most recently, The Rise and Resurrection of the American Programmer *and* The Decline and Fall of the American Programmer. *You can contact him at* **http://www.yourdon.com**.

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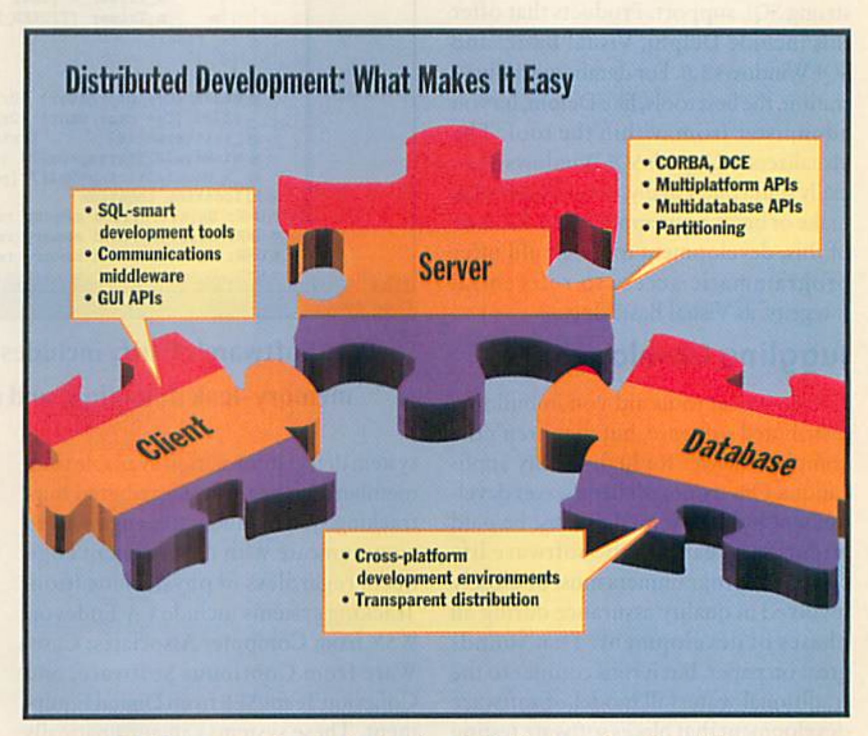
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Distributed development of distributed applications doesn't have to be a distributed nightmare. By Charles D. Knutson

Developing Quality

One of the biggest problems in client/server application development is the double-edged nature of the concept "distributed." On the one hand, the applications you develop must work in a *distributed* environment, where collaboration takes place without regard to national or geographic boundaries. On the other hand, development of the applications may be distributed, with teams in far-flung locations working on pieces of the same program.

The first challenge is primarily an engineering issue; the second is a management issue. Together, the distributed development of distributed software is a nightmare when you also have to meet the goal of creating high-quality software under tight schedules. Fortunately, a handful of tools and management techniques offer hope.



Different tools can help simplify the work of building each piece of a distributed application.

Getting There from Here

A challenge common to all distributed applications is that someone, somewhere has to get information from here to there and back. One of the most costly aspects of distributed software has been in building the underlying communication mechanisms. Writing directly to TCP/IP or Sequenced Packet Exchange (SPX) is not particularly pleasant, and slightly higher-level solutions like Sockets and Transport Level Interface (TLI) are only marginally better.

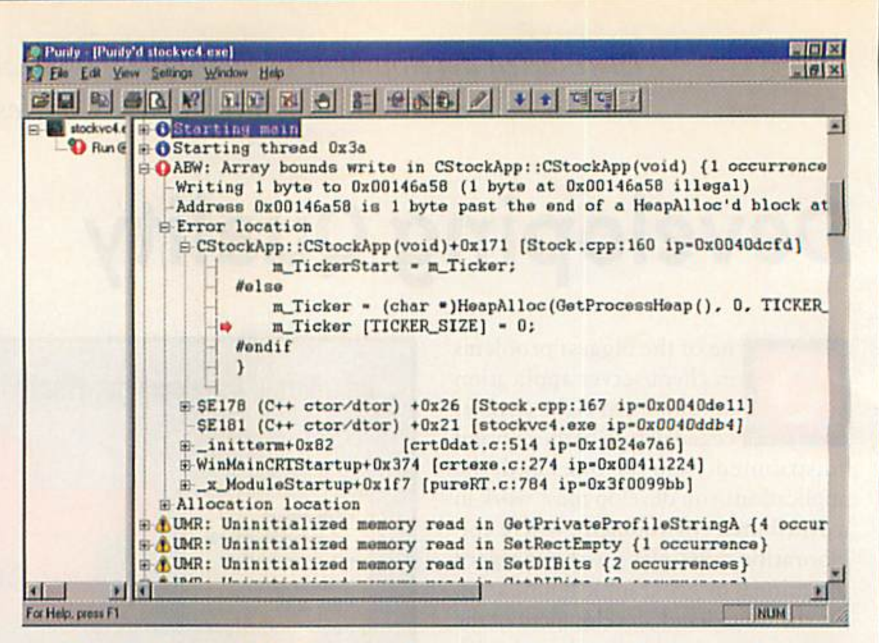
The need for easy-to-use communication mechanisms has inspired middleware technologies like the Common Object Request Broker Architecture (CORBA) specification from the Object Management Group (OMG). This specification lays out a mechanism for communication between distributed objects using object request brokers (ORBs) by way of an interface definition language (IDL). In this architecture, clients desiring to access the services of another object make requests to an ORB, which brokers a connection between the two and permits the client to access the object implementation. Many companies are now developing middleware products that are either based on or are compliant with CORBA, including IBM's SOMobjects Developer Toolkit.

Similarly, within the Windows environment, Microsoft's Distributed COM (or DCOM, formerly known as Network OLE) lets you build applications with objects that work together on distributed machines. Objects can communicate using DCOM without any object knowing the physical location of any other object. Microsoft exhibits a wait-and-see attitude toward CORBA.

Microsoft based its Distributed COM remote procedure call on the Open Software Foundation's Distributed Computing Environment (OSF's DCE). This potentially means that, sometime in the future, distributed objects in Windows applications will be able to communicate with non-Microsoft operating systems.

Middleware products can make it easier for objects to communicate in situations where nothing better exists. Luckily for developers of distributed applications, something better does exist in the form of distributed databases. Development environments for client/server database applications can help you build sophisticated clients to access the services provided by back-end database products such as Gupta's SQLBase and Microsoft's SQL Server. These tools embed middleware capabilities within higher-level functions, so you don't have to worry about the gritty details of getting packets from here to there. Leading development packages include Borland International's Delphi Client/Server Suite 2.0; Microsoft's Visual Basic Enterprise Edition 4.0; Gupta's SQL Windows 5.0; and Powersoft's PowerBuilder Enterprise for Windows. *continued*

To pick the right tool for your applications, make sure the product you're considering supports all the database engines used throughout your organization (some environments, such as Borland's Delphi Client/Server Suite 2.0 and Microsoft Visual Basic Enterprise Edition 4.0, can access up to eight different database engines). Also look for strong SQL support. Products that offer this include Delphi, Visual Basic, and SQLWindows 5.0. For database administration, the best tools, like Delphi, let you administer from within the tool. The visualizers in Gupta's SQLWindows especially stand out. Finally, data integrity can make or break your application. Because of this, development tools should offer programmatic access to referential integrity, as Visual Basic does.



Pure Software's Purify includes error checking, filter analysis, memory-leak detection, and multiple application testing.

Juggling Developers

Development tools aid you in building distributed software, but they aren't the complete answer for high-quality applications. One axiom of client/server development holds that quality must be paid attention to early in the software life cycle, and programmers must be closely involved in quality assurance during all phases of development. That sounds great on paper, but it runs counter to the traditional waterfall model of software development that places software testing near the end of the process.

Compounding this problem is the fact that many companies still live with a wall (and some hostility) between the development and testing organizations. Development builds product until they decide it's done, and they toss it over the wall to the QA department. The testing team stands at the end of the assembly line with a piece of chalk, scrawling a big "X" on products doomed for reworking and throwing them back over the wall.

Add distributed development to the mix and the goal of quality software written on time seems impossible. To handle the increased complexity of distributed products, development and test engineers must live in greater harmony and interact earlier in the development process. And what do you do when the development department sees quality assurance as the testing department's job? Or when developers are expected to do unit testing but don't know how to start?

The best way to make the development and testing teams harmonize is to make system defect information available to all members of the team. Distributed bug-tracking systems allow test engineers to communicate with development engineers regardless of physical location. Tracking systems include CA-Endevor/WSX from Computer Associates; Case-Ware from Continuus Software; and Cohesion Team/SEE from Digital Equipment. These systems can automatically pass work among members of a development group, regardless of where they may be. You can augment these systems by combining the bug-tracking system with an automated testing facility (see "Testing, Testing," page 97). This way, tests can automatically run while an engineer is gone for the night, and bug reports can be waiting in the morning.

So how do you get development engineers and QA experts to convert to new policies and technologies? The most common approach—to mandate change and then live with armed rebellion until the most hostile individuals either go away or stop whining—is probably not the best. A more Trojan Horse approach works on the psyche of the development engineer. You take a product like Pure Software's Purify, which runs in the background and automatically reports problems. You can get development engineers to buy into background testing by emphasizing one of its important benefits: Because testing tells developers about problems before the QA staff uncovers them, developers are saved the embarrassment of having bugs entered into the tracking system where they will be visible to management. The engineer is now doing unit testing, albeit not in a structured way.

Another example is code coverage tools, such as QC/Coverage (CenterLine Software) and PureCoverage (Pure Software). Code coverage—keeping track of how much code actually was tested during a test—is often viewed as a QA function, since that department is the one preoccupied with how much of the code their system tests are touching. But why shouldn't development engineers use these tools whenever they take the product for a spin? Shouldn't they also have a clue about how much coverage they are getting before it enters formal system testing? Despite the distributed nature of the development, such tools help ensure software quality during the development process, without what often seems like the intrusion of formal testing.

Unwanted Blasts from the Past

Legacy code is another nasty problem developers face. Imagine this: You've just been handed 50,000 lines of code you've never seen before, and you need to find and fix a single bug. You probably spend two full weeks just tracking your way through the code, change one line, recompile, and the bug goes away. You

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hope. You also hope that you haven't introduced some other bug by failing to understand dependencies in the code that weren't visible using grep. And how does your effort affect the other far-flung members of the development team?

Discover, from Software Emancipation Technology, is one tool that provides developers with a view of code dependencies and allows for sharing information among members of a distributed team. One of the first things engineers often do when faced with legacy code is build a picture that can help them understand where to hunt for a bug. Automated tools can build these pictures and share the knowledge with distant teammates.

Fighting Fire with Fire

When technology grows in complexity, the source of quality lies in the same technology. If distribution is your problem, distribution can also be your solution. As project management tools grow in complexity, their functions will evolve and interconnect. Bug tracking and code coverage testing will unite to form distributed development tools. One of the most visible waves involves the use of distributed objects as building blocks for distributed systems.

Perhaps the best example of this is also the world's most distributed system. Software Emancipation plans to allow Discover to provide its wealth of information by way of Hypertext Markup Language (HTML), so that distributed teams can browse source code and other information on the Web. Again, this is using a distributed system (the Web) to support distributed development.

Others take this idea a step further and suggest that we should look at using the already distributed Web to replace traditional forms of distributed client/server applications. And why not? With Common Gateway Interface (CGI), we can input information via a Web page, and with Java applets, portions of a distributed application can download to a client workstation and execute. Netscape Navigator as a universal client front end? Stranger things have happened. But we can be sure that development teams are going to keep spreading out, and applications are spreading out with them. Whether you're a developer or a coordinator, make sure you've got the right tools before you're spread too thin. ■

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Shrink-wrapped and custom tools ease the testing of client/server applications. *By Stephen R. Quinn and Muralidhar Sitaram*

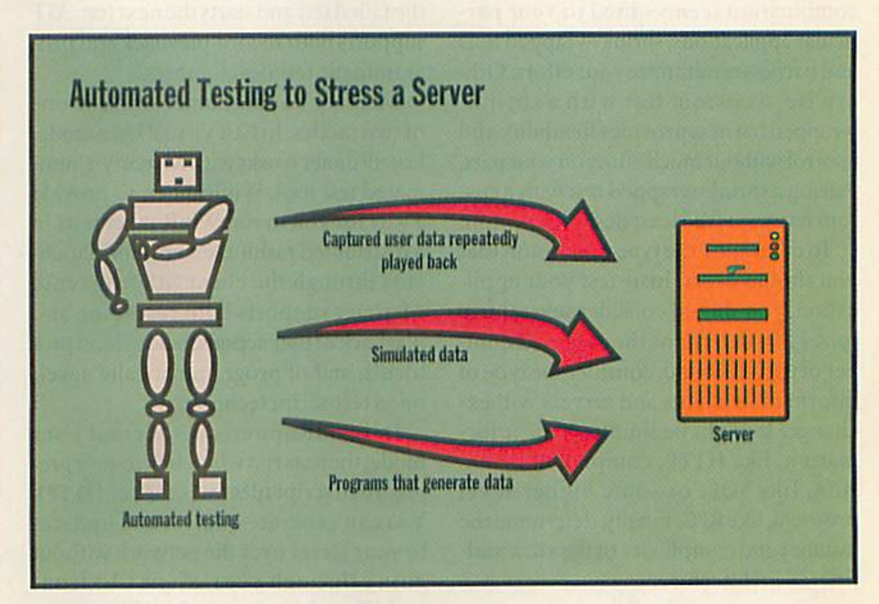
Testing, Testing

So you've already done the simple parts: designing your client/server application and writing the code. Now it's time to see how well it works under real-world conditions. You need to run load tests that place large demands on the system. And you *don't* want to be the one pounding the keyboard for 100 hours straight. The answer: automated testing. By mechanically varying the load on your system, automated testing can provide you with the information you need.

Unfortunately, as you move from a two-tiered to a multitiered architecture, the level of skill required to create the automated tests increases as the interaction between layers becomes more complicated. But you can take advantage of automated testing in your multitiered architecture. This article presents some tricks and tips that will help you get started with automated testing.

Your testing should provide you with detailed—and calming—information on reliability (Will your system lock up with increased load?), scalability (Will access time degrade with increased load?), and design flaws (Can the system architecture handle the level and complexity of use?). This last point is important: the problem with many client/server systems is, indeed, their architecture. Load testing helps isolate architectural problems. To achieve the desired results, you are, of course, better off optimizing your system's architecture up front and not as an afterthought. To optimize your design, you should do the following.

- Minimize the amount of network traffic. One way to do this is to encapsulate the SQL or use remote procedure calls (RPCs) instead of sending raw SQL across the network.
- Insulate the whole system from errant or failed processes. One failed client should not lock up others.
- Reduce the contention for resources. For example, in a database client/server system, reduce the length of transactions to avoid database-resource contentions.



The simplest case of client/server: a two-tiered architecture. This is easy to test using shrink-wrapped automated test tools.

Getting Testy

By this point, you should have the bug population mostly quelled and be ready to take on the more systemwide and performance-associated aspects of the application. To create an automated test in a client/server environment, you need both a test harness (which provides the infrastructure in which the tests run) and one or more test scripts.

A test harness schedules a test to run at a specific time, for a specific time interval, on a specific machine on a network. A commercially available test harness typically also includes an integrated test-development environment. A test harness collects information at run time, including details on failures, performance statistics, and network status.

In general, there are four ways to create a test. You can record the actions of real users on your GUI front end and then replay those actions later. Similarly, you might capture the post-GUI application output directly and play that back later. (For example, to test a Web server, you might capture the HTTP requests from the client to the server and then replay them.) You can programmatically generate one or more test scripts (e.g., scripts that capture the low-level graphical subsystem protocol instead of recording user actions that screen resolutions and fonts can affect). Finally, you can write a white-box test (explained below) that talks to your system's API directly and mimics user actions.

Thus, tests that you create and run in the test harness typically perform several tasks. They might drive a GUI front end to simulate the actions of a live user. They might also interact directly with a server by circumventing the GUI front end: This is called a *white-box test*. In addition, they might execute the protocol between the client and the server (e.g., SQL and HTTP requests).

Most tests must fit your specific application; therefore, you cannot buy shrink-wrapped tests from a vendor. But there

are tools available that simplify the process of creating your own tests.

Automated client/server harness-and-test solutions fall into four categories, depending on whether each part is shrink-wrapped or custom-developed. Custom test-and-harness combinations are the most flexible, but naturally they require the most work on your part. If the combination seems suited to your particular applications, shrink-wrapped tests and harnesses minimize your effort. Otherwise, a custom test with a shrink-wrapped harness provides flexibility and control without much effort on your part. Pairing a shrink-wrapped test with a custom harness is the least desirable option.

To determine the type of solution that you should use to load-test your application, you should consider several factors. First, determine the expected number of users. Second, consider the type of information clients and servers will exchange. It might be simple, static information, like HTTP; complex information, like SQL; or some higher-level protocol, like RPC. Finally, determine the number and complexity of tiers in a multitiered architecture.

Shrink-Wrapped Tests and Harnesses

Our experience indicates that it's more cost- and time-effective to use a shrink-wrapped harness. If you're testing a multitiered product where you need to simulate many users, we recommend using a custom white-box test. A two-tiered system with a small number of users using a standard protocol, such as HTTP or SQL, tests best with a shrink-wrapped test harness and test-development environment.

New technologies are emerging from vendors of automated test tools. For example, in the high-end client/server tools market, Pure Software's PurePerformix Script-and-Go technology allows you to capture the interaction between your application and the input device, such as a character terminal, an X Window System terminal, or a PC. This is a variant of record/playback technology, which captures the low-level subsystem protocol. PurePerformix can also capture SQL traffic between your client and database server. The captured SQL traffic goes into scripts later. PurePerformix can arrange a mix of scripts to run from one central driver machine.

Client/server applications can manage a complex information life cycle, where data is entered, processed, and delivered throughout the corporate enterprise. Softbridge's Automated Test Facility (ATF) addresses the demands of the multitiered, multiapplication architecture. You can run ATF from a single control machine to follow the life cycle of a data record. If the process fails, ATF stops the failed test and starts the next test. ATF supports both record/playback and programmatic test development.

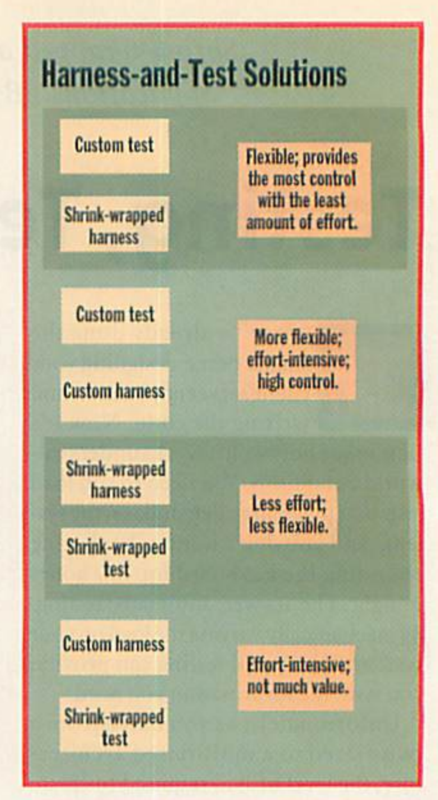
Mercury's LoadRunner works in one of two modes. In GUI Virtual User mode, LoadRunner works with Mercury's automated test tool, WinRunner, to provide a way for you to run WinRunner tests in a distributed fashion on multiple PC clients through the client GUI front end. Mercury supports both recording and playback of user actions, of low-level protocols, and of programmatically developed test-script technology.

In LoadRunner's DB Virtual User mode, the tests run white-box tests or prerecorded script files (e.g., SQL or HTTP). You can generate queries and updates to your server over the network without going through your client GUI front end. The advantage of white-box testing is that you can run multiple virtual users on each machine. (Mercury claims you can have multiple GUI virtual users, but you might run into problems with memory constraints and setup issues.)

On networked Unix machines, LoadRunner can generate multiple virtual database users that send SQL (or other types of traffic) directly to the server. Using multiple virtual database users, you can simulate hundreds or (in theory) thousands of users with the right hardware. Mercury also provides tools to collect SQL from your client for subsequent use in DB Virtual User tests. This technology can do either white-box testing or recording and playback of SQL.

Segue Software's QualityWorks products also simulate multiple virtual users. QA Partner:Distributed allows you to run scripts on multiple client GUI front ends simultaneously (with the added benefit that clients can be on different platforms). QA DBTester can send SQL directly to a database server, thereby circumventing your client front end.

SQA's LoadTest works in conjunction with the company's Robot automated test tool. You drive the PC client front end with Robot scripts that LoadTest distributes to machines over the network. The Robot scripts load your server with queries and updates. Your limit is the number of PCs that are available or that you're willing to set up and use for testing. (With this system, the number of PCs limits the number of virtual users.) LoadTest therefore supports the recording and playback of user interaction in a distributed situation.



Multitiered architectures often require white-box tests for the middleware layers.

Using PurePerformix, QA DBTester, or LoadRunner's DB Virtual User technology, you can simulate large numbers of users to verify the scalability of your client/server architecture. You can also do this with Mercury Interactive's GUI Virtual User technology or SQA's LoadTest technology (using one virtual user per PC in the distributed test).

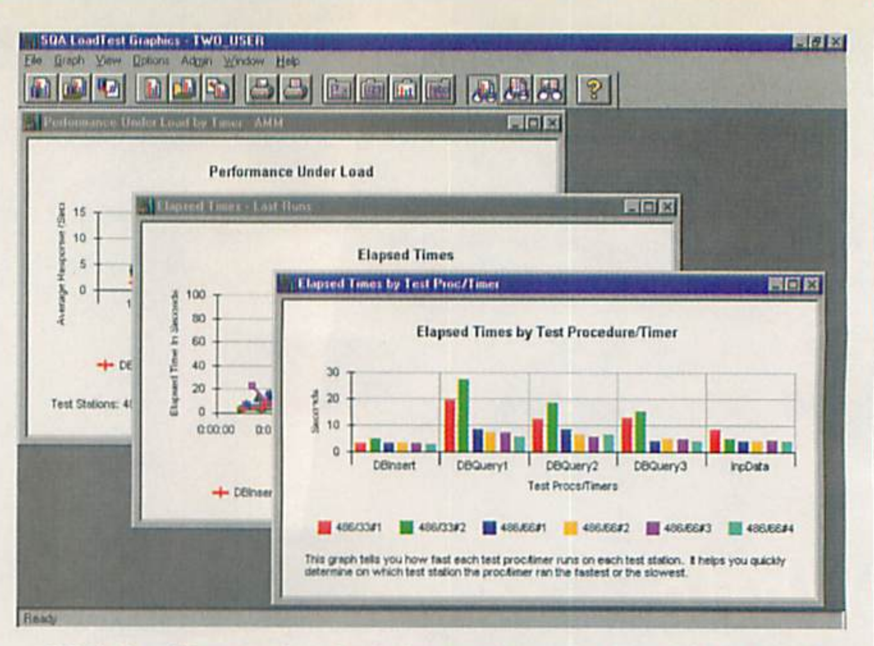
Both distributed GUI testing and distributed multiprocess virtual-user testing capture detailed information for later analysis. In some cases, you can write the script with functions that provide timing information. Of course, your test harness tells you when a specific test fails.

The disadvantage of simulating multiple users on a single machine is that you're not generating real network-traffic conditions. But it's easier to simulate a large

number of users. You can generate real network-traffic conditions by running one virtual user per PC through the client front end. But this process is too labor-intensive and expensive—you need more than 1000 machines.

There are other pitfalls when simulating multiple users on a single machine. Primarily, you're running a small number of PCs and predicting the performance degradation from the results of the simulation. If the degradation is predictable, you're fine. But if performance degrades, your test done with 20 machines will not reveal the serious degradation that occurs with 21 machines.

We recommend using multiprocessed virtual users and GUI virtual users to verify scalability. The only alternative is to work with an outside testing lab to perform massive single-user-per-PC tests; this is an expensive proposition, but it might be the only way in certain cases.



SQA's LoadTest product includes good graphics capabilities that give you a visual representation of your results.

Custom Tests and Harnesses

A number of situations mandate a custom rather than a shrink-wrapped solution. Where flexibility and control are paramount, you'll want to at least consider writing the tests yourself. Such situations include an application that's out of the

A SAMPLE TEST

```
/* The vuser_run function is called when the Vuser receives a run command.
*/
int LR_FUNC
vuser_run(LR_PARAM p)
{
   // Test class initialization ...
   for (int i = 1; i <= giterations; i++) {
     lr_output_message("Running iteration %d", i);
     // Other tests ...
     // Rendezvous before doing Select and Propagate test
     lr_rendezvous("SelectAndPropagate");
     lr_start_transaction("SelectAndPropagate");
     // Select record
     if (!DCO_SelectRecord(recp)) {
        // Selection failed. Log message and end transaction as failure
        lr_error_message("Record could not be selected in callBrowser");
        lr_end_transaction("SelectAndPropagate", LR_FAIL);
    } else {
       // Selection succeeded. Propagate Join selections.
      if(!DCO_PropagateJoin(tup))
          // Propagation failed. End transaction as failure.
          lr_end_transaction("SelectAndPropagate", LR_FAIL);
      // Select and Propagate test succeeded. End transaction as success.
      lr_end_transaction("SelectAndPropagate", LR_PASS);
    }
    // Other tests ...
  }
  return 0; /* Test passed */
}
/*%END_SECTION%*/
```

mainstream, platform combinations that exceed the abilities of the shrink-wrapped tools, and performance characteristics that are special cases. The downside is that it requires more effort to develop and verify these tests.

You can write custom test solutions completely in-house, and tools are available to help you do just that. For example, Database Accessory (DA), from Integrated Computer Solutions, takes you through the whole client/server applications development process. The tests deliver keystrokes to the GUI using a scripting language called Tool Command Language (TCL, pronounced "tickle"). These scripts drive the application and hence simulate user input. TCL can query the database independently and match the internal state of the application with the results of the independent database query.

This verification method offers error checking that might be appropriate in any number of custom automated test scenarios. You can use DA's method with most of the shrink-wrapped automated

test solutions, but typically you get all your feedback through the client GUI front end.

Blood, Sweat, and Tiers

Another reason to go the custom-test route is if the communication mechanism between your client and server uses technology that shrink-wrapped tools cannot effectively capture. Then, writing white-box tests may be the only way to go (other than using GUI-automated scripts). Our company, Quintus, uses an RPC protocol between each tier in the company's multitiered architecture. But shrink-wrapped tools cannot capture RPCs, so we decided to write our own white-box tests instead.

One advantage of white-box testing in a multitiered architecture is that you can use the APIs between each tier to test their interaction. To build white-box tests for Quintus's customer-information management applications suite, we took advantage of internal APIs while using LoadRunnner's harness capabilities.

Quintus tested the interaction not only between the white-box client and the intermediate servers but also between those servers and the database. This ensured that each tier was tested independently from the other tiers and was healthy. The white-box tests also simulated the same network traffic between the servers and the real clients.

The text box "A Sample Test" on page 101 shows a code snippet of a white-box test written against Quintus's APIs. This snippet shows the use of the LoadRunner functions that captured transaction information and sent messages to a central controller. The white-box tests were designed to perform typical operations that a user might perform on the keyboard: creating a new record, updating an existing record, and deleting a record.

Quintus also wrote a number of tests that simulated the client/server interaction process, such as connecting and disconnecting from the database and initializing the client subsystem. Simple scripts repeated the tests a specified number of times. Other tests exercised each API call independently, allowing testers to gauge their behavior under stress.

When configuring database servers and networks, it was necessary to ensure that the database servers could handle several hundred connections. This involved configuring the database server machine with enough memory, storage, and shared memory.

Don't Be a Crash-Test Dummy

The use of automated test tools can save time and effort, but only if you let them. When using automated test tools in the software development process, take the path of least resistance. *For example*, don't waste resources trying to make your test tool "see" custom controls in the target application's GUI. If control type mappings (e.g., mapping a custom button to the type button) don't fix the problem, you can create automated test scripts that don't use the errant control.

Another way to maximize your engineering resources is to start small in client/server automated testing. Start a pilot program with modest expectations and

plans. As you garner some success in your automated testing, widen the scope and depth of the testing.

When running your tests, you need information about what the application is doing while the tests are running. Consider how best to monitor the progress of your automated tests in real time, using information such as database and intermediate server log files; user connections; record, page, and table locks; and log files generated by the actual tests.

Ideally, you should install a network sniffer to monitor the flow of packets on the network to identify any bottlenecks. Don Lanoue, a senior technology consultant at Digital Network Services, says that while a half-second response is fine, if you're a support agent on the phone, you need instant answers. Your network bandwidth can make the difference.

Lanoue, who is a veteran of modeling small and large systems, explains that "there are customers out there that have networks that don't run well. We go in and collect data and feed it into a modeling tool. Once you have the network modeled, then you can play 'what if.'"

But Lanoue warns that not just any system administrator can effectively accomplish this task. If you're considering using a modeling tool, check out CACI's ComNet III and Systems and Networks' Bones. Both tools do LAN and WAN network simulations.

Put to the Test

If you plan to deliver client/server software, an automated test harness and test-development tool should be a part of your test process. Our experiences at Quintus lead us to strongly recommend spending your resources on test development and not on test-harness development.

Quality and scalability in a client/server system must be built into the architecture. Make sure you understand the intricacies of your architecture and allocate the time and resources needed to perform automated testing on it. Write white-box tests that simulate multiple users from a single machine. We leveraged our testing effort by using tests simulating multiple users. Finally, if you're using automated tests in a client/server environment, always start small. Do a pilot of your test, and when that works, scale up. This method works. ■

WHERE TO FIND

Integrated Computer Solutions
Cambridge, MA
(617) 621-0060
http://www.ics.com/IntraNet

Mercury Interactive Corp.
Sunnyvale, CA
(408) 523-9900
http://www.merc-int.com

Pure Software, Inc.
Sunnyvale, CA
(408) 720-1600
http://www.pure.com

Segue Software, Inc.
Newton Centre, MA
(800) 922-3771
http://www.segue.com

Softbridge, Inc.
Cambridge, MA
(617) 576-2257
fax: (617) 864-7747

SQA, Inc.
Woburn, MA
(800) 228-9922
http://www.sqa.com

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Lab Report

Hardware

10 Multifunction Telephony Boards

We test devices that put fax, modem, and voice capability all in one place.
By Maggi Bender, Dorothy Hudson, Jim Kane, and John McDonough

How would you like a new fax machine, a telephone answering machine, and an upgrade to your PC's modem and sound capabilities—all for one low price? If so, then you're ready for a telephony device: the all-in-one Swiss Army knife of PC communications. Telephony devices integrate data/fax modems, voice-mail functionality, a speakerphone and microphone for telephone conversations, and CD-quality audio for $200 to $300. If you're still not convinced, most telephony card vendors will sweeten the deal with Internet telephone capability and on-line connectivity software.

Telephony devices provide a central management system for busy small office/home office (SOHO) workers. These products consolidate e-mail, voice mail, and faxes, making it easy to retrieve them even when you're on the road. They also reduce desk clutter (you can sell your fax machine, answering machine, and external modem). The telephony devices with sound capabilities add to your listening pleasure because they provide 3-D sound effects for your Rebel Assault space battles and multimedia applications.

For this roundup, we tested 10 products (eight internal and two external) that bring us closer to the vision of integrating telephones with computers. These telephony devices have full-duplex speakers and microphones for hands-free telephone conversations (you can use a headset instead of the speakers if you want privacy). The best telephony cards we tested are total out-of-box solutions with easy-to-use telecommunications management software. Software telephony utilities commonly bundled with the telephony devices include multiple-mailbox voice mail, fax reception and fax broadcasting to and from multiple users, and paging services.

To evaluate the cards, we ran performance tests that measure each modem's data-throughput rate. (All of them have at least 28.8-Kbps modems.) The speed of the internal modem, after all, is the main performance issue for telephony cards. We also put heavy emphasis on features and usability. We wanted to make sure the internal cards and external boxes were easy to install and use. We found the self-configuring plug-and-play devices the easiest to install because you don't have to fuss with IRQ/DMA jumpers or switches.

BYTE BEST
TELEPHONY BOARDS

Aztech Labs AT3300 Audio Telephony, Hayes Accura 28.8, and US Robotics Sportster Voice 28.8 Faxmodem PVM

These three telephony boards tied for first with their high performance, ease of use, and features.

Dial 33.6 for Faster Throughput

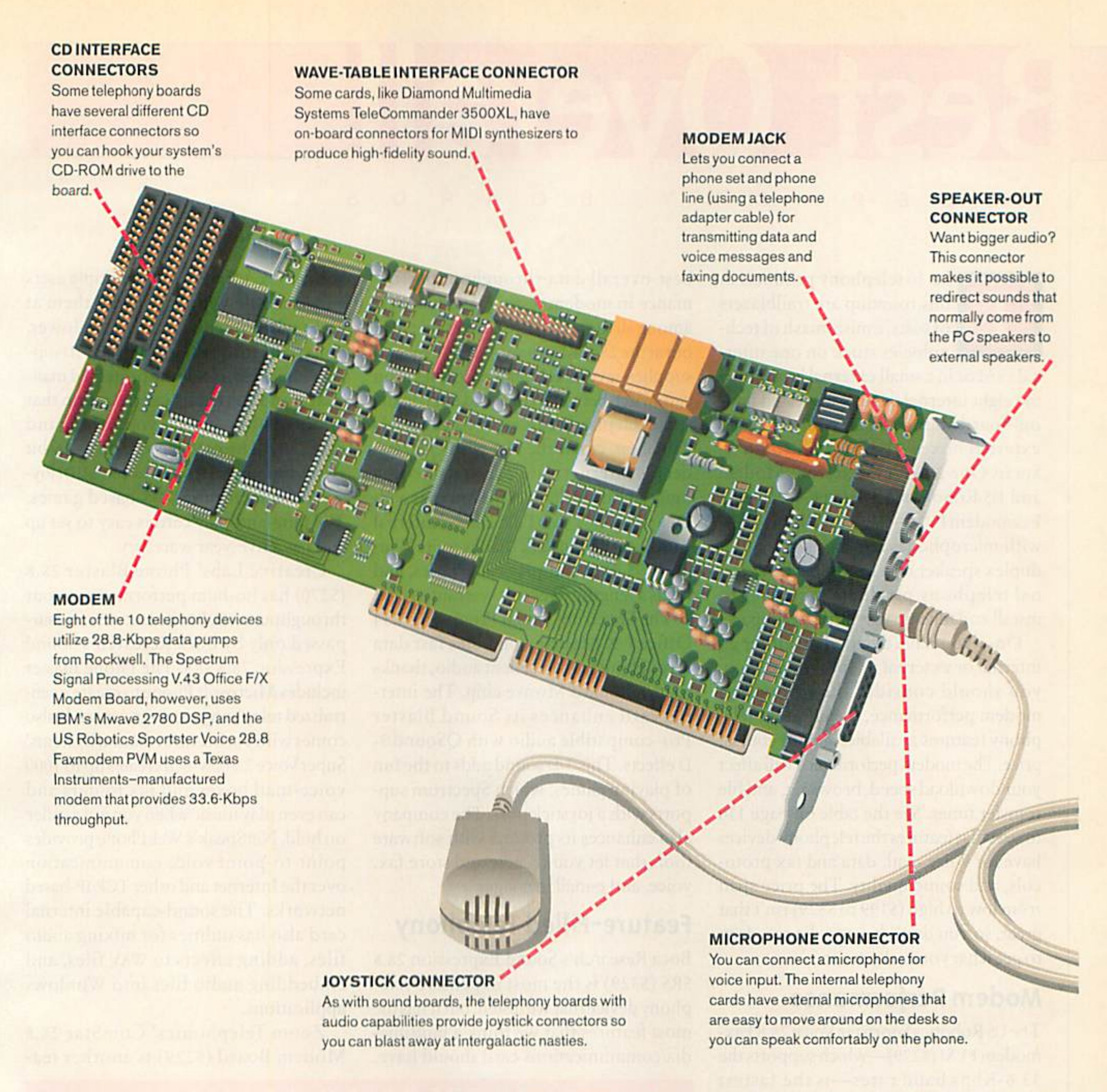
The fastest modem in our testbed is the US Robotics Sportster Voice 28.8 Faxmodem PVM, which (despite its misleading name) is the only telephony card we tested that supports the latest V.34 protocol for transmission speeds of 33.6 Kbps. (Remember that to get the higher speed, you need a 33.6-Kbps modem at both ends of the connection.) The new protocol upstages the predominant 28.8-Kbps modem baud rate by using a more advanced coding mechanism for sending and receiving data. You can boost DSP-based modems that have 28.8-Kbps data pumps to the 33.6-Kbps baud rate with a flash ROM upgrade.

US Robotics' Sportster proved to be consistently the best performer in our gauntlet of file transfer benchmarks, albeit not really 16 percent faster than the closest 28.8-Kbps modems: Hayes Microcomputer Products' Accura 28.8, Best Data Products' Smart One 2834VLX External Modem, and Aztech Labs' AT3300 Audio Telephony.

Calling SOHO Users

File transfer performance is certainly important, but the telephony devices we tested are more than just glorified modems. Their many telephony features can make your small office sound like a big corporation's front desk when someone calls you. They come with professional-sounding prerecorded greetings, and you can set up multiple mailboxes for different users at your location. We recommend you keep voice-quality settings as low as possible to minimize the amount of space needed to store messages; voice-mail messages are disk hogs. Fortunately, most voice-mail software lets you set parameters for message length and mailbox size.

For long-distance access, you can dial



in to check your messages and even have them forwarded to remote locations; most telephony devices will even page you when they receive messages and faxes. Callers can also get nearly instant information about your business by accessing fax-on-demand services when you're not in the office to take their calls. Password ID lets only authorized users dial into their mailboxes, and caller ID lets you screen annoying callers. You can view incoming faxes on-screen before printing them.

The vendors bundle a demo copy of voice-over-the-Internet software like Netspeak's WebPhone or VocalTec's Internet Phone and utilize Digital Simultaneous Voice and Data (DSVD) or Alternating Voice and Data (AVD) technology. Modem applications can typically run at 19.2-Kbps data rates while in DSVD mode. On-line game combatants and technical support people can use DSVD to keep their conversation going without disconnecting the voice channel to connect a data channel. For on-line services, the vendors provide software for CompuServe, America Online, and the Imagination Network. They also toss in a Web browser.

Most of the telephony cards have sound capabilities, but you won't need that if you already have a dependable Sound Blaster Pro–compatible card in your system. Having a sound chip on the card isn't really necessary for telephony applications, but it's a nice bonus if you have just a mono speaker. If you are happy with your PC's sound, then you can save some money with an inexpensive "nonsound" telephony device like Best Data's Smart One 2834VLX External Modem ($209) or Connectware's PhoneWorks 28.8 ($229). *continued*

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Best Overall

TELEPHONY BOARDS

The 10 telephony products in this roundup are trailblazers of sorts, a mish-mash of technologies stuck on one internal card or in a small external box. Six of the eight internal devices we tested have on-board sound chips, while the two external boxes—Best Data Products' Smart One 2834VLX External Modem and US Robotics' Sportster Voice 28.8 Faxmodem PVM—are basically modems with microphones and a jack for a full-duplex speaker or a headset. The external telephony products are easier to install and take up very little desk space.

Once you have decided on either an internal or external telephony solution, you should consider the following: modem performance, the different telephony features available, and, of course, price. The modem performance will affect your download speed, browsing, and file transfer times. See the table on page 110 to see what features the telephony devices have for voice mail, data and fax protocols, and sound quality. The price span from low to high ($199 to $329) isn't that great, so you don't have to dig too deep to get what you really want.

Modem Performance

The US Robotics Sportster Voice 28.8 Faxmodem PVM ($279)—which supports the 33.6-Kbps baud rates—is the fastest modem in our performance benchmarks, but there are several modems with 28.8-Kbps data pumps that are almost as quick as the Sportster. Hayes Microcomputer Products' Accura 28.8 ($259), Best Data Products' Smart One 2834VLX External Modem ($209), and Aztech Labs' AT3300 Audio Telephony ($199) can really move data through telephone wire with their Rockwell data pumps. The next best in performance is the Spectrum Signal Processing V.34 Office F/X Modem Board ($299), which uses IBM's Mwave 2780 DSP data pump. We recommend getting the fastest modem possible because fast and reliable connections are the lifeline for telephony users.

The Hayes Accura 28.8 has the second-best-overall data-throughput performance in modem testing, and it is best among all the telephony devices that max out at the 28.8-Kbps baud rate. Hayes also supplies several telephony utilities. You can switch between voice and data on the same telephone call with VoiceView's TalkShop, cruise the Net with Quarterdeck's InternetSuite 2, and make free long-distance calls over the Internet with Quarterdeck's WebTalk. Hayes' internal card is easy to install, thanks to its Windows 95 plug-and-play capabilities, and it has a lengthy five-year warranty.

The Spectrum Signal Processing V.34 Office F/X Modem combines fast data throughput with excellent audio, thanks to its on-board Mwave chip. The internal card enhances its Sound Blaster Pro–compatible audio with QSound 3-D effects. This 3-D sound adds to the fun of playing games, which Spectrum supports with a joystick port. The company also enhances its product with software tools that let you receive and store fax, voice, and e-mail messages.

Feature-Filled Telephony

Boca Research's Sound Expression 28.8 SRS ($329) is the most expensive telephony device that we tested, but it has the most features that we think a multimedia/communications card should have. You can broadcast faxes to multiple users and schedule your PC to send them at night when telephone rates are lower. Voice-mail features include caller ID support, multiple password-protected mailboxes, and automatic call detection that distinguishes among voice, fax, and data calls. The card has excellent 16-bit stereo sound, and it has a 15-pin MIDI joystick connector for DOS-based games. The plug-and-play card is easy to set up and has a five-year warranty.

Creative Labs' Phone Blaster 28.8 ($270) has ho-hum performance in our throughput tests, but its feature set is surpassed only by Boca Research's Sound Expression 28.8 SRS. The Phone Blaster includes Microsoft Phone to create a centralized telephony message center. It also comes with Pacific Information Systems' SuperVoice 2.2b, which creates up to 1000 voice-mail boxes and fax folders and can even play music when you put a caller on hold. NetSpeak's WebPhone provides point-to-point voice communication over the Internet and other TCP/IP-based networks. The sound-capable internal card also has utilities for mixing audio files, adding effects to WAV files, and embedding audio files into Windows applications.

Zoom Telephonics' ComStar 28.8 Modem Board ($229) is another fea-

ON THE SOFTWARE SIDE

Vendors provide software utilities that enhance their telephony hardware. An easy-to-use interface lets typical SOHO users get up and running within minutes of installation. All the telephony boards we tested have software packages that include three main components: voice, fax, and data. The easiest-to-use programs are those that provide an icon-based central location where you can launch the applications; these include Trio Information Systems' Trio Communication Suite 5.0 (shipped with Aztech's board), Hayes' Smartcom Message Center LE, and US Robotics' QuickLink II.

Voice mail is one of the most attractive features of telephony. All the software packages we saw let you easily create multiple voice-mail boxes with both prerecorded and personalized greetings. They also offer password-protected remote access for mailbox users.

Digital Simultaneous Voice and Data (DSVD) allows data transmission during a normal phone call, which lets you do things like discuss changes to a file while simultaneously transferring it to another location. DSVD technology may become more popular as a way of conversing with opponents on modem-run multiplayer games.

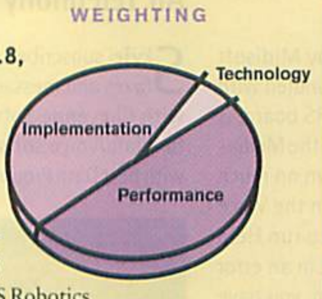
You can easily create, view, send, and receive faxes from within the same application. The packages also allow fax broadcasting (i.e., sending a fax to multiple locations without manually dialing each number).

LAB RESULTS

TELEPHONY BOARD RATINGS

BEST OVERALL

WEIGHTING





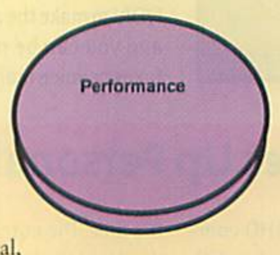
Aztech Labs AT3300 Audio Telephony, Hayes Accura 28.8, and US Robotics Sportster Voice 28.8 Faxmodem PVM

It's a three-way tie! As the lowest-priced board in our roundup, the Aztech Labs AT3300 Audio Telephony ($199) offers great performance and value. It provides fleet file transfer speeds, has a full plate of telecommunications features, and pumps out 16-bit stereo audio with 3-D sound effects. A fast performer, the Hayes Accura 28.8 is easy to use with its Windows 95 plug-and-play capabilities. Our high-performance winner, the US Robotics Sportster Voice 28.8, is also easy to use and has some nice features.

	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	FEATURES	OVERALL RATING
Aztech Labs AT3300 Audio Telephony	**$199**	★★★	★★★★	★★★★★	★★★★	★★★★	★★★★
Hayes Accura 28.8	**$259**	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
US Robotics Sportster Voice 28.8 Faxmodem PVM	**$279**	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
Best Data Products Smart One 2834VLX External	$209	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
Spectrum V.34 Office F/X Modem Board	$299	★★★	★★★	★★★★★	★★★★	★★★	★★★★
Zoom Telephonics ComStar 28.8 Modem Board	$229	★★★	★★★★	★★★★	★★★★	★★★★	★★★★

HIGH PERFORMANCE

WEIGHTING





US Robotics Sportster Voice 28.8 Faxmodem PVM

The US Robotics Sportster Voice 28.8 Faxmodem PVM ($279) has a big advantage over the 28.8-Kbps modems with its support for the faster 33.6-Kbps V.34 protocol. As long as you have Sportsters at each end of the connection, you will see ultrafast file transfers over phone lines. This external device is a tight little box with an integrated microphone and full-duplex speaker for hands-free phone conversations. Telephony services include voice mail with multiple mailboxes, remote message and fax retrieval, and pager notification.

	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	FEATURES	OVERALL RATING
US Robotics Sportster Voice 28.8 Faxmodem PVM	**$279**	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
Hayes Accura 28.8	$259	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
Best Data Products Smart One 2834VLX External	$209	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
Aztech Labs AT3300 Audio Telephony	$199	★★★	★★★★	★★★★★	★★★★	★★★★	★★★★
Spectrum V.34 Office F/X Modem Board	$299	★★★	★★★	★★★★★	★★★★	★★★	★★★★

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

ture-filled telephony device that deserves mention. This is a well-rounded telephony solution that has a strong set of features, that's easy to use, and that costs $100 less than Boca's telephony solution. The internal device has an external speaker and a free-standing microphone that is easy to move into a comfortable position for telephone conversations. You can plug in a headset to maintain private telephone conversations. The ComStar 28.8 Modem Board has some slick features, such as a speed dialer that works from a point-and-click directory and Radish's VoiceView software for switching between voice and data on a single telephone line.

Telephony on a Budget

At $209, Best Data Products' Smart One 2834VLX External Modem is an inexpensive telephony box that provides fast data throughput with a 28.8-Kbps modem. The tiny, 7-ounce Best Data telephony device has all the voice-mail features that you'll need to handle communications when you're on the road. The system can activate a remote pager whenever you receive new messages, and it has an automated attendant for message handling. Password protection ensures voice-mail confidentiality.

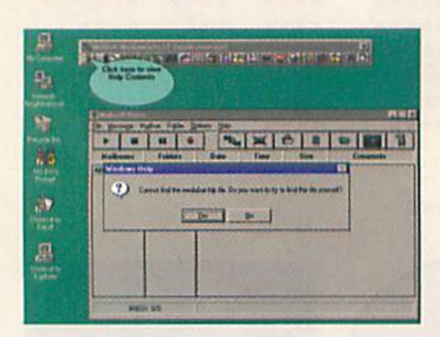
Connectware's PhoneWorks 28.8 ($200) is a low-budget internal telephony solution that's a good choice if you don't need blazing modem performance and are happy with your sound card. Once you get past the rocky installation of the device drivers, the internal card's telephony features for fax management, voice mail, Internet access, and Internet Phone are easy to use. Connectware also offers ISDN terminal adapters to increase your bandwidth down the road, and the card has a healthy three-year warranty.

continued

Details

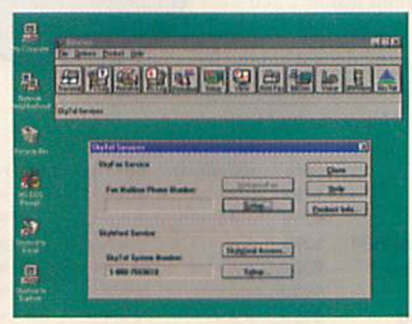
Expressions

The program group created by Midisoft MediaWorks, the software bundled with Boca's SoundExpression 28.8 SRS board, is crammed with 26 icons. Opening the MediaWorks applications bar cuts down on much of the confusion. However, when the Voice Mail applet is open, attempts to run Help from the applications bar result in an error message. To correct this problem, you have to select "Yes" in the "Do you want to try to find this file yourself?" dialog box and find the file manually.



Air Telephony

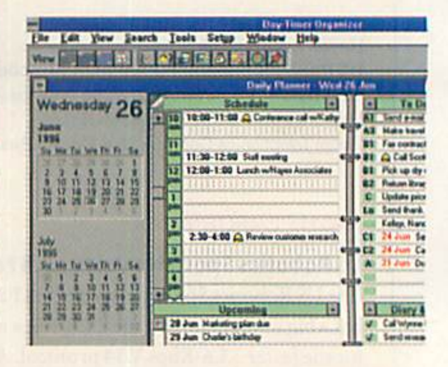
SkyTel subscribers in midflight can access faxes and messages from their home PC with Cheyenne Software's BitWare F/D/V fax/data/voice software, which is bundled with Best Data Products' Smart One 2834VLX



External Modem and Zoom Telephonics' ComStar 28.8 Modem Board. You just have to double-click on a SkyTel icon in BitWare F/D/V to make the air-to-ground connection, and you can be notified about incoming faxes or voice mail.

Save a Tree

In another step toward the paperless office, Day-Timer Organizer for Windows is bundled with Diamond Multimedia's TeleCommander 3500XL. The software Day-Timer has all the features of its paper sibling, and then some. Anyone who has used the portable Day-Timer will feel at home with the software version, which includes daily, weekly, and monthly planners. This program integrates a calendar, an address book, a to-do list, a notebook, and an expense tracker.



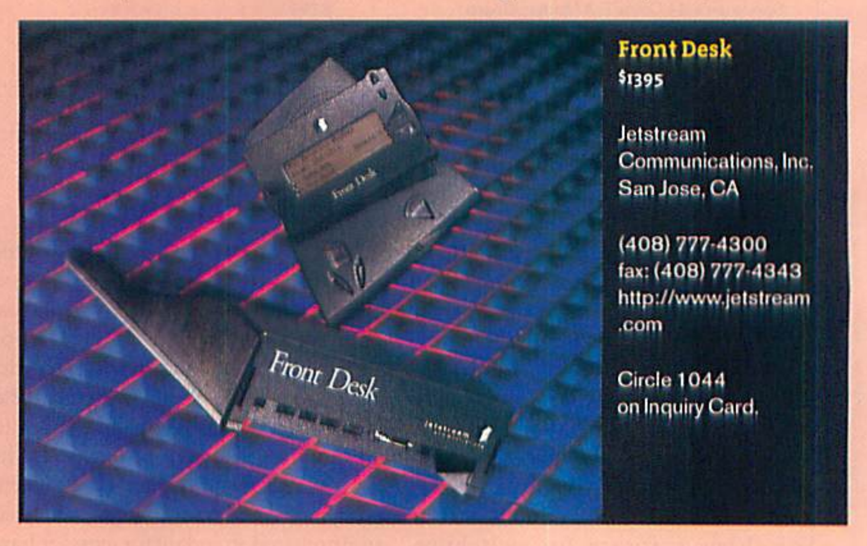
Front Desk Serves Up Personal Telephony on ISDN

There's a new product in the SOHO communications-management market, but it's not a telephony card. Jetstream Communications' Front Desk is an ISDN-based home office hub that routes and manages your voice mail, faxes, and data. Front Desk is not an all-in-one solution like the telephony cards; it's more of a personal PBX router that uses your existing telephone, fax, and modem equipment.

At $1395, Front Desk costs $1000 more than a high-priced telephony card, but Jetstream president David Frankel says the advantage with Front Desk is its wide-bandwidth ISDN connectivity. (He says 90 percent of telephone subscribers in the U.S. now have access to ISDN lines.) A single ISDN line supports two simultaneous calls, which eliminates the need for running multiple lines into your office. With Front Desk, you can talk to one person while a second caller is being routed to the answering machine.

Another advantage with Front Desk is that because it's an independent piece of hardware, you don't have to leave your PC on all the time. The notebook-size hub also houses a battery that provides up to four hours of backup in the event of a power failure. Front Desk has memory for storing voice and fax messages. The Front Desk Display with a 20-character LCD connects to the hub, but Jetstream also provides Windows 95–based software for PC control. Front Desk services include simultaneous call management; single-button access to call-handling features such as hold, conference, and transfer; voice mail; and faxing.

The hub has a single ISDN port and three analog ports for a telephone, fax machine, or



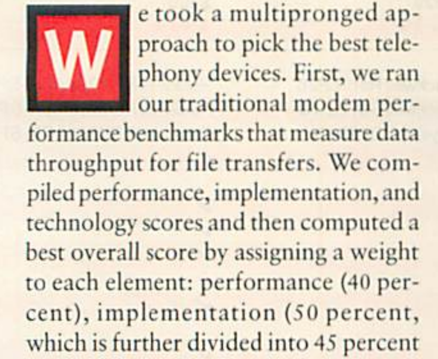
Front Desk
$1395

Jetstream Communications, Inc.
San Jose, CA

(408) 777-4300
fax: (408) 777-4343
http://www.jetstream.com

Circle 1044 on Inquiry Card.

Test Specs



We took a multipronged approach to pick the best telephony devices. First, we ran our traditional modem performance benchmarks that measure data throughput for file transfers. We compiled performance, implementation, and technology scores and then computed a best overall score by assigning a weight to each element: performance (40 percent), implementation (50 percent, which is further divided into 45 percent usability, 45 percent features, and 10 percent value), and technology (10 percent).

Performance

Since the core of the telephony devices is their on-board modem, we ran tests that measured how fast they could transmit and receive files over simulated telephone lines. Testers connected like pairs of modems to a Telecom Analysis Systems ((908) 544-8700) Series II modem tester. The machine emulates line-impairment conditions with mild white noise, near and far echo, and a short satellite delay, so the modems had to clear some interference. The loop emulator generates an EEIA1at both ends of the connection. These conditions represent a direct telephone connection at 2000 feet and is the shortest local loop.

During the test cycle, the modems transfer three types of files (compressed, graphics, and text) that are representative of what an on-line browser might encounter. Lab technicians measured each pair for one-way and two-way transmissions with the telephony devices configured to receive data from the computer at the fastest rate they support. Testers installed serial communications enhancement software that took advantage of the 16550 and overcame the limitations of standard Windows communications drivers. Testers enable V.42bis data compression and V.42 error correction, even if the modem's default settings specify other protocols. Technicians also set up the modems to use hardware (Ready to Send) flow control, rather than XON/XOFF. For data compression and error control parameters, we used the default window and dictionary sizes.

Under our one-way transmission tests, modem A calls modem B. Modem A then sends a file and hangs up. Modem A then repeats the process three more times. During a one-way transmission, modem B only receives data; it does not send anything back to modem A. During the two-way transmission tests, modem A still makes four calls to modem B; however, when modem B answers, both modems simultaneously send files to one another. The modems from Boca Research, Creative Labs, Connectware, and Zoom Telephonics failed some of the two-way tests, which ultimately hurt their overall performance score.

Usability/Features

To judge these products' level of usability, we used them to send faxes. Our objective was to see how easy it is to install the communications software and how easy it is to use once it was fired up. We took a long look at voice-mail capabilities to see, for instance, how many messages the products supported and if you could easily access messages from remote locations. We studied the communications capabilities of each product. We checked to see if the documentation was clear and technically correct. And we weighted and scored the important features that we believe a telephony product should have. *continued*

modem. The hub also provides a serial interface for connecting to a user's PC. The serial connection is used to communicate with the Front Desk Manager PC software, as well as for providing the PC with high-speed data communications for accessing the Internet or a remote LAN. It is through the serial connection that Front Desk performs as an ISDN modem for the PC.

"Please Hold..."

The Front Desk hub itself is a handsome desktop accessory with an aerodynamically sloped front. It is about 1-foot long so if it takes up too much desk space, you can keep it under the desk or mount it on the wall. Setup is easy with recognizable symbols for the ISDN connector, Front Desk display, telephone jacks, and serial connector. You just have to plug in your telephone and fax machine.

Front Desk provides key telephony services. It can detect those callers you deem important based on caller IDs or dialed numbers that the hub recognizes. If you're talking on the telephone, Front Desk can greet a caller, notify you via the Front Desk display and call-waiting beep, then give you the option to answer it. If you are away from the office, Front Desk can reroute important calls to alternative numbers such as a cellular phone, while you can have your regular calls sent to voice mail. You can set things up so the important caller gets a message such as "Please hold while my Front Desk attempts to find me."

Front Desk's call-handling capabilities are pretty much foolproof. The display makes it easy to transfer or hold calls by placing the commands on the LCD right next to the appropriate buttons, just like with a bank's ATM. For accessing messages remotely, Front Desk lets you check caller IDs before listening to voice mail. It also tells you how many fax pages are coming in if, for instance, you don't want too many pages transferred to the hotel fax machine. And, of course, the best feature may be the No Calls mode that reroutes all callers to voice mail or just lets important callers get through.

–John McDonough

Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of their monthly PC Digest. *To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of The McGraw-Hill Companies.*

TELEPHONY BOARDS FEATURES

Vendor/model	Aztech Labs AT3300 Audio Telephony Card (BYTE Best)	Best Data Products Smart One 2834VLX	Boca Research SoundExpression 28.8 SRS	Connectware PhoneWorks 28.8
Price	$199	$209	$329	$200
Overall rating	★★★★	★★★★	★★★★	★★★★
MODEM				
Data pump manufacturer/model	Rockwell RCV288ACi/DP	Rockwell RCV288dpi	Rockwell R6682-26	Rockwell RCV288ACFi-SP
Controller manufacturer/model	Rockwell RCV288ACi/DP	Rockwell L3903-57	Rockwell R6723-13	Rockwell RCV288ACFi-SP
DSP manufacturer/model	Rockwell RCV288ACi/DP	N/A	Crystal CS4231A	Rockwell RCV288ACFi-SP
Hayes Escape command set	✔	✔	✔	✔
TIES Escape command set	✔			
Break Escape command set	✔	✔	✔	✔
Hardware handshaking	✔	✔	✔	✔
Error correction	✔	✔	✔	✔
Cellular mode	✔	✔		
Asynchronous	✔	✔	✔	✔
Synchronous	✔	✔		
AutoSync	✔	✔		✔
Full-duplex	✔	✔	✔	✔
ITU V.42 error correction	✔	✔	✔	✔
MNP 10EC error correction	✔	✔		
MNP 10 error correction	✔	✔		
MNP 2-4 error correction	✔	✔	✔	✔
LAPM error correction	✔	✔	✔	✔
ITU V.42bis compression	✔	✔	✔	✔
MNP 5 compression	✔	✔	✔	✔
MNP 7 compression				
SOUND				
MPC-2-compatible	✔	N/A	✔	
Sound Blaster Pro-compatible	✔	N/A	✔	
8- and 16-bit stereo sound	✔	N/A	✔	
Stereo FM synthesis (OPL3)	✔	N/A	✔	
MIDI MPU-401 UART support	✔	N/A	✔	
Software-configurable wave-table connector	✔	N/A	✔	
VOICE MAIL				
Number of voice-mail boxes	999	999	89	1000
Amount of bytes used per each second of message	3.6 KB	5 KB	3 KB	7.2 KB
Remotely access new or old messages and faxes	✔	✔	✔	✔
Remotely record or change personal greeting	✔	✔	✔	✔
EXTERNAL CONNECTIONS				
RJ-11 modular phone connector	✔	✔	✔	✔
Electret/Dynamic microphone jack	✔	✔	✔	✔
Line input jack	✔		✔	✔
Line output jack	✔	✔	✔	✔
Wave-table connector	✔		✔	
CD-ROM INTERFACES SUPPORTED				
IDE			✔	
Sony				
Mitsumi				
I/O ADDRESSES				
Plug and play	✔	N/A	✔	
Software configurable	✔	N/A	✔	
Number of IRQs supported	5	N/A	11	4
Number of DMA channels supported	3	N/A	3	
MISCELLANEOUS				
Full-duplex speakerphone	✔		✔	✔
Supports all fax protocols	✔	✔	✔	✔
Supports V.34, V.32bis, and V.32	✔	✔	✔	✔
Nonvolatile RAM stores modem configuration		✔	✔	
CUSTOMER SUPPORT				
Warranty (years)	1/P, L, R	5/P, L, R (first 90 days)	5/P, L, R	3/P, L, R
Phone	(510) 623-8988 x 312	(818) 773-9600	(407) 997-6227	(214) 997-4111
Toll-free phone	(800) 886-8859	(800) 632-2378	none	(800) 357-0852
On-line address	http://www.aztechca.com	http://www.bestdata.com	http://www.bocaresearch.com	http://www.connectware.com
Inquiry no.	**1080**	**1081**	**1082**	**1083**

BYTE Best = BYTE Best ✔ = yes; N/A = not applicable.

Warranty: P=parts; L=labor; R=return to customer.

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

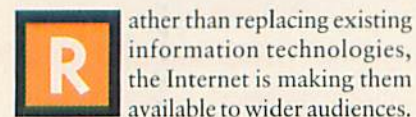
Creative Labs Phone Blaster 28.8 PnP*	Diamond Multimedia Systems TeleCommander 3500XL	Hayes Microcomputer Products Accura 28.8 BYTE BEST	Spectrum Signal Processing V.34 Office F/X	U.S. Robotics Sportster Voice 28.8 with Personal Voice Mail BYTE BEST	Zoom Telephonics Zoom ComStar 28.8
$270	$299	$259	$299	$279	$229
★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
Rockwell RCV288dpi	Rockwell RCV144ACISP	Rockwell RCV288dpi	IBM Mwave 2780 DSP	Proprietary	Rockwell RCV288dpi
Rockwell RCFSP R6674-16A	Rockwell RCV144ACISP	Rockwell R6723-13	IBM Mwave 2780 DSP	Texas Instruments TIC5X	Rockwell R6723-17
N/A	Rockwell RCV144ACISP	Rockwell R6693-14	IBM Mwave 2780 DSP	Texas Instruments TIC5X	N/A
✔	✔	✔	✔	✔	
					✔
		✔	✔		✔
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
					✔
✔	✔	✔	✔	✔	✔
	✔				
	✔				
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
✔					✔
✔					✔
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
✔					
✔	✔	N/A	✔	N/A	
✔	✔	N/A	✔	N/A	
✔	✔	N/A	✔	N/A	✔
✔	✔	N/A	✔	N/A	
✔	✔	N/A	✔	N/A	
✔	✔	N/A	Built-in wavetable MIDI	N/A	
Unlimited	10,000	10	Unlimited	10	Unlimited
15.5 KB	1.5-5 KB (user-selectable)	1 KB	4 KB	2 KB	1800 or 3600
✔	✔	✔ (new messages only)	✔ (messages, not faxes)	✔	✔
✔	✔		✔	✔	0
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	
✔	✔		✔		
✔	✔	✔	✔		
✔	✔	N/A			
✔	✔	N/A		N/A	
	✔	N/A	✔	N/A	
	✔	N/A		N/A	
✔		✔		✔	✔
✔	✔		✔		✔
7	9	8	7	8	4
6	4	N/A	4	N/A	N/A
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔
✔		✔		✔	
1/P, L	1/P, L, R	2/P, L, R	1/P, L, R	5/P, L, R	7/P, L, R
(408) 428-6600	(408) 325-7000	(770) 840-9200	(604) 421-5422	(847) 676-7010	(617) 423-1072
(800) 998-5227	(800) 468-5846	(800) 429-3739	(800) 667-0018	(800) 342-5877	(800) 631-3116
http://www.creativelabs.com	http://www.diamondmm.com	http://www.hayes.com	http://www.spectrumsignal.com	http://www.usr.com	http://www.zoomtel.com
1084	1085	1086	1087	1088	1089

* Phone Blaster upgradable to 33.6 Kbps in firmware.

To make your corporate information available on demand, you need one of a new breed of specialized Internet data-access servers.

By Mark Hettler

Serving Up Data on the Web



Rather than replacing existing information technologies, the Internet is making them available to wider audiences. Corporations with large databases see this as a publishing opportunity. To exploit it, they need a new type of database application that allows anyone with an Internet connection and a Web browser to view and enter data, submit queries, and produce reports.

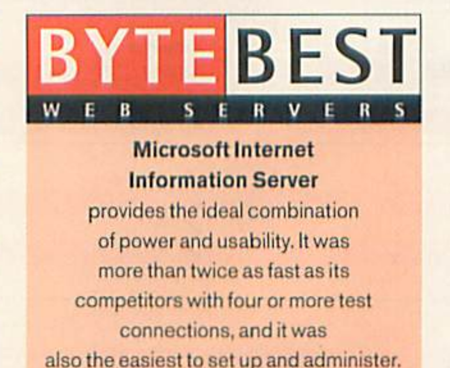
Answering the need are new database servers like the three that NSTL tested for this report. All less than a year old, these Windows NT–based Internet servers—Microsoft Internet Information Server (IIS) 1.0, Oracle WebServer 2.0, and O'Reilly & Associates' WebSite Professional 1.0—offer facilities for querying databases and incorporating the results into Web pages, as well as facilities for updating databases based on user input. Our evaluations focus on the products' database-access functions rather than their usefulness as general-purpose Internet servers.

WebSite Professional and Oracle WebServer were officially released in June; because of deadlines, we tested prerelease copies of both. Another product, Netscape's LiveWire Professional, wasn't far enough along for us to test (see the text box "Netscape Grabs a Live Wire" on page 114).

NSTL developed an on-line order-entry application for each product, evaluating ease of learning and use by setting up, configuring, and administering each product, and finally testing each application's performance. Microsoft SQL Server 6.5 was the database for the Microsoft IIS and O'Reilly WebSite Professional tests. For Oracle WebServer, we used Oracle7 Server for NT 7.2.

Microsoft Internet Information Server

Microsoft offers two tools in this category. The Internet Database Connector (IDC) is part of IIS, while the Web Assistant is part of Microsoft SQL Server. These two tools take a pull and push approach, respectively, to getting data from the database to the Internet. The Web Assistant "pushes" data to the Internet, producing static Web pages, while the IDC "pulls" information from a database in response to queries.



Microsoft Internet Information Server provides the ideal combination of power and usability. It was more than twice as fast as its competitors with four or more test connections, and it was also the easiest to set up and administer.

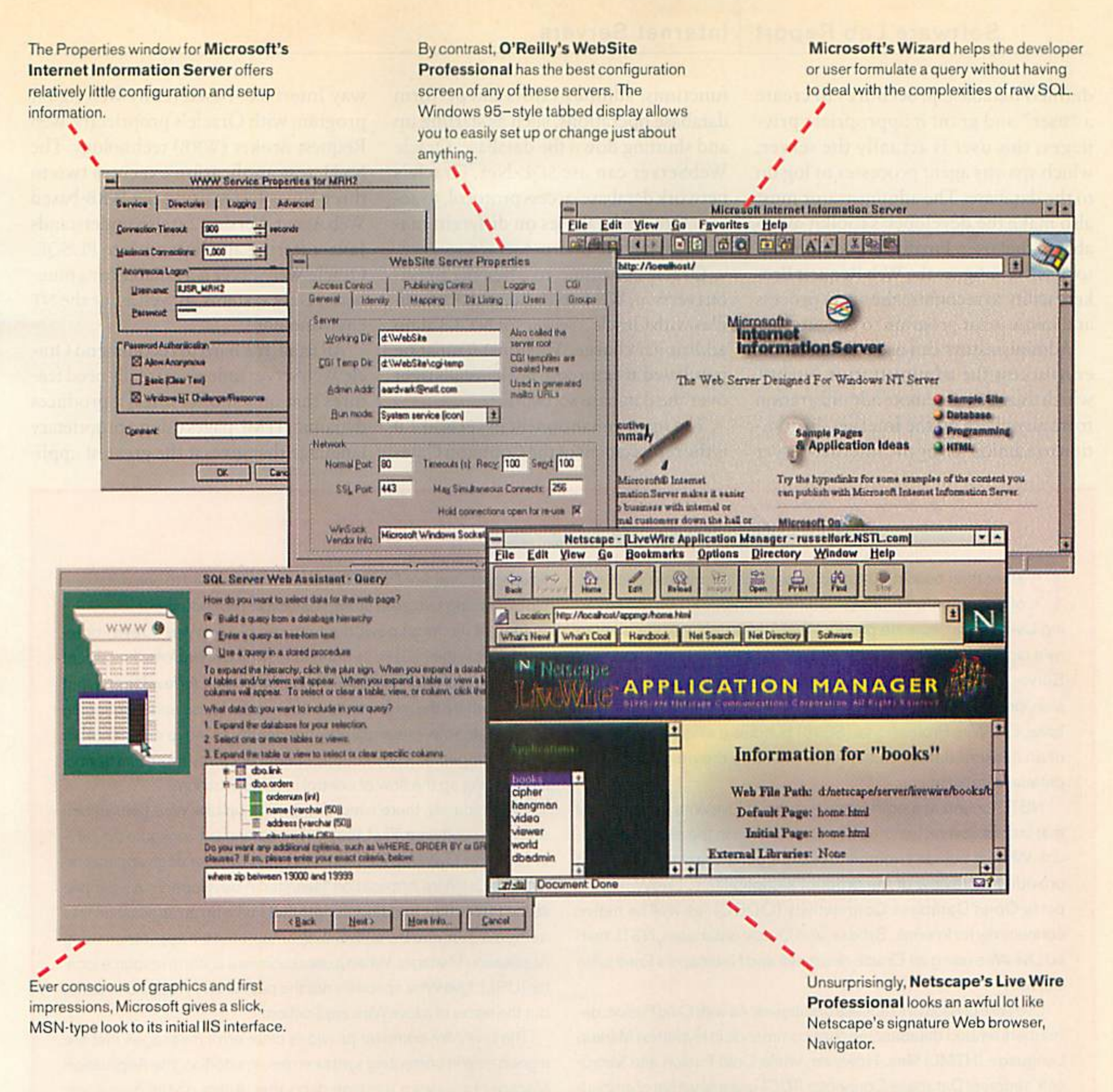
Although we looked at IIS in combination with SQL Server, you can use the two products separately. Any Internet server can access pages produced by Web Assistant. The IDC uses the Open Database Connectivity (ODBC) extension to access databases, and thus it supports a variety of database types. Our tests focused on the IDC's dynamic page-generation capabilities.

To generate a dynamic Hypertext Markup Language (HTML) page, a uniform resource locator (URL) requests an IDC control file that specifies ODBC connection information (including user ID and password), the SQL command, and a template file. The URL can also pass parameters to specify any item in the IDC file and convey variables to be incorporated into the SQL command.

The template file consists of standard HTML and proprietary IDC commands to define a detail section that occurs once for each data record returned. Developers can embed values returned by the query as well as variables originally passed to the control file. The template language also supports IF ... ELSE logic.

The IDC is based on Microsoft's ISAPI architecture. When a URL specifies an IDC control file, the system automatically executes the IDC DLL program. The DLL controls connection to the database, execution of the SQL command, and final formatting based on the specified template file. Microsoft IIS offers the best performance of all the tested products.

While IIS is available for free via downloading from Microsoft's Web site (http://www.microsoft.com), the actual cost for most users will be the difference in price between Windows NT Server and Windows NT Workstation. In NSTL's experience, most Internet servers work well on NT Workstation, but Microsoft IIS is the exception; it will install only on NT Server.



The Properties window for **Microsoft's Internet Information Server** offers relatively little configuration and setup information.

By contrast, **O'Reilly's WebSite Professional** has the best configuration screen of any of these servers. The Windows 95–style tabbed display allows you to easily set up or change just about anything.

Microsoft's Wizard helps the developer or user formulate a query without having to deal with the complexities of raw SQL.

Ever conscious of graphics and first impressions, Microsoft gives a slick, MSN-type look to its initial IIS interface.

Unsurprisingly, **Netscape's Live Wire Professional** looks an awful lot like Netscape's signature Web browser, Navigator.

Microsoft's server has a good interface but not the best configuration section.

The bottom line: Microsoft IIS is the fastest performer and the easiest product to use.

Oracle WebServer 2.0

Whereas Microsoft's components work well with other vendors' products, Oracle's tightly integrated suite of products work only with one another—a reflection of the company's mainframe heritage, perhaps. The Web Agent, which handles database requests, won't work with other Internet servers and can access only Oracle databases.

Rather than specifying SQL commands and output formatting via text files, WebServer stores this information in the database itself using PL/SQL, Oracle's language for database procedures. Its procedural logic, subroutines, and nested database cursors allow a great deal of flexibility in incorporating data into Web pages. A developers' toolkit, which you install when setting up the Web Agent, consists of predefined PL/SQL procedures and functions that provide HTML formatting capability.

Here is a URL to generate dynamic HTML using Oracle WebServer: http://www.nstl.com/sample/owa/query?state=CA. WebServer recognizes the string *owa* as a call to Web Agent, and the string following it as the name of a PL/SQL procedure for Web Agent to execute. Any parameters passed in the URL must correspond to arguments accepted by the PL/SQL procedure.

Setting up and administering WebServer are considerably more complicated than these procedures are for the other tested products. After installing the software, an administrator must access the administration facility and set up a Web listener (i.e., the server part that accepts requests from Internet users). All the other products do this as part of the software installation.

In addition, before WebServer can execute database applications, the administrator must set up at least one Web Agent. This involves running a number of pre-

defined database procedures to create a "user" and grant it appropriate privileges; this user is actually the server, which spawns agent processes to log on to the database. The administrator must also make the developer's toolkit available to that user. Finally, the administrator has to configure the Web Request Broker facility to recognize the agent process and know what program to execute.

Administrators can use a Web browser to access the administration facility, which thus allows remote administration from anywhere on the Internet. In addition to administering the Internet-server functions, administrators can perform database operations, such as starting up and shutting down the database. Oracle WebServer can use SQL-Net, Oracle's network database-access protocol, to access Oracle databases on different machines from the Internet server.

Oracle continues to offer the previous version, WebServer 1.0, which it bundles with Oracle7 Server for NT 7.3 at no additional charge. Version 2.0 must be purchased at extra cost, but it installs right over the database software.

The main enhancement in version 2.0 is the replacement of the Common Gateway Interface–based (CGI) Web Agent program with Oracle's proprietary Web Request Broker (WRB) technology. The NSTL test application executes two to three times faster using the WRB-based Web Agent. Version 2.0 also understands Java, offering an alternative to PL/SQL. Oracle WebServer is available for a number of Unix systems, as well as for the NT environment.

All in all, it's hard to recommend Oracle WebServer unless you really need features that only it offers. Yes, it produces dynamic HTML pages using a proprietary language that gives it the greatest appli-

Netscape Grabs a Live Wire

Rather than building data-access mechanisms into each one of its products, Netscape Communications is currently offering LiveWire, a separate product that integrates with the company's higher-end servers, such as FastTrack Server and Enterprise Server. The standard version of LiveWire, like Allaire's Cold Fusion, provides database-access functions but has no actual database. LiveWire Professional ($695) bundles a single-user version of an Informix database server to facilitate the development of database applications.

NSTL looked at a prerelease version of LiveWire Professional that lacked several features due for inclusion in the released product. While it couldn't complete NSTL's performance test suite, it provided a preview of the product's capabilities. LiveWire supports Open Database Connectivity (ODBC), as well as native connectivity for Informix, Sybase, and Oracle databases. NSTL tested LiveWire using an Oracle database and Netscape's Enterprise Server.

LiveWire uses Java to access databases. As with Cold Fusion, developers embed database-access commands in Hypertext Markup Language (HTML) files. However, while Cold Fusion and Microsoft's Internet Database Connector (IDC) use a small set of embedded database commands, Java offers all the power of a complete programming language. To execute complex programming logic, the application can call external Java scripts rather than embedding all the code in an HTML file. Thus, LiveWire offers the power and flexibility of Oracle's PL/SQL without being limited to one database type or having to create stored database procedures.

One of the most powerful features of LiveWire's Java implementation is the `redirect` command, which abandons the current HTML file and begins processing another one. A developer might use this where the user wants to query a database and, depending on the outcome, either display the results or move on to another activity altogether. The `redirect` command provides great flexibility in setting up the flow of control in an application.

Unfortunately, there's more to setting up LiveWire than just installing the software. First, the administrator must configure the server to enable LiveWire functions and then register each application with the LiveWire Application Manager. A developer must compile all the HTML files and Java scripts that make up an application into a single object, and the administrator must start the application using Application Manager. When a user submits a uniform resource locator (URL), LiveWire specifies not the path to an HTML file or script but the name of a LiveWire application.

The LiveWire compiler provides clear error messages that are a great help in correcting syntax errors. In addition, the Application Manager provides a run-time debugger. Although the prerelease version couldn't complete the performance test suite with eight test clients, NSTL tested it with one, two, and four clients; LiveWire's performance was almost identical to that of Oracle WebServer at all three user loads.

DATABASE SERVER RATINGS

BEST OVERALL

Microsoft Internet Information Server

Ease of use, versatility, and outstanding speed make this the clear winner.

	VERSION	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	OVERALL EVALUATION
Microsoft Internet Information Server	**1.0**	**Free**	★★★★	★★★★★	★★★★★	★★★★	★★★★
Oracle WebServer	2.0	$2495	★★★	★★	★★★	★★	★★
WebSite Professional	1.0	$499	★★★	★★★★	★★★	★★★★	★★★

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

cation flexibility and power of all these products. But WebServer is far more difficult to learn and use than the others, offers inferior performance, and supports only Oracle databases.

WebSite Professional

WebSite Professional is an enhanced version of O'Reilly's popular WebSite Standard, and it offers enhanced Internet security features. Rather than building its own data-access mechanism, O'Reilly chose to bundle Allaire's Cold Fusion, which you can purchase separately (in Standard or Professional versions) and use with other Internet servers.

Cold Fusion approaches database access much like Microsoft's IDC does. It uses ODBC, sends SQL commands to a database, and formats the results using an HTML template. But Cold Fusion embeds the ODBC specification and SQL commands directly in the HTML template rather than using two separate files.

Like IDC, Cold Fusion uses special commands to delineate result sections that repeat for each record returned by a query. But unlike in IDC, a single Cold Fusion template file can incorporate multiple queries, with each result section referencing a specific query. Unlike in Oracle's PL/SQL, you can't nest one query inside the result loop of another.

The lack of IF ... ELSE logic (which Cold Fusion Professional does offer) greatly limits flexibility in displaying and formatting results. But the availability of multiple query results allows some options not available in Microsoft's IDC; for example, a data-entry form can have multiple data-driven pick lists.

Another difference from IDC is the use of CGI. Although WebSite Professional provides its own interface (which is called WS-API) for applications development, Cold Fusion is a CGI application. Here's a sample URL: http://www.nstl.com/cgi-bin/dbml.exe?template=templates/query.dbm&state=CA. In this

FEATURES

	Microsoft Internet Information Server	Oracle WebServer	WebSite Professional
MAJOR COMPONENTS			
Internet server	✔	✔	✔
Database-access tools	✔	✔	✔
DATABASE SOFTWARE			
Web browser	✔		✔
Personal Web server			✔
HTML editor			✔
INTERNET-SERVER FEATURES			
HTTP server	✔	✔	✔
FTP, gopher servers	✔		
WinCGI support		✔	✔
ISAPI support	✔		✔
SSL, encryption support	✔	✔	✔
S-HTTP support			✔
Directory-level read/write permissions	✔		✔
Virtual trees	✔	✔	✔
Allow/disallow directory browsing	✔		✔
Multiple virtual servers	✔	✔	✔
ADMINISTRATION FEATURES			
Administer using Web browser	❖	✔	
Password-protect administrator access from browser	❖	✔	
Administer multiple servers from single location	✔	✔	✔
Dynamic load monitoring	✔		
Automatic logging to database table	✔		
Log-analysis tools			✔
Start up/shut down database using Web browser	❖	✔	
DATABASE-ACCESS FEATURES			
Support multiple database engines	✔	Oracle only	✔
Database on different computer from Internet server	✔	✔	✔
Allow multiple concurrent users	✔	✔	✔
Incorporate database data in HTML pages; display images from database	✔	✔	✔
Incorporate data passed from another HTML page	✔	✔	✔
Pages generated dynamically on access	✔	✔	✔
Can use database-specific SQL extensions	✔	✔	✔
Single URL can initiate multiple SQL commands	✔	✔	✔
Multiple query-result sets in single HTML page	❖	✔	✔
Nested result sets (for each row returned in query A, execute query B)		✔	
Conditional results display (IF...ELSE)	✔	✔	
Transactions (begin, commit, rollback)	✔	✔	✔
Database access via CGI, native API	✔	✔	✔
Database access via Java		✔	✔

✔ = yes; ❖ = available in next version.

PERFORMANCE

	Microsoft Internet Information Server	Oracle WebServer	WebSite Professional
One user	17.7	25.8	19.6
Two users	19.7	35.3	28.6
Four users	25.8	63.2	53.9
Eight users	43.7	114.1	165.8

Times are in seconds; lower numbers = better performance.

We tested each of these servers using one, two, four, and eight test clients sending requests to an order-entry application. The test program sends uniform resource locators (URLs) to the server as soon as it receives the response to the previous request; there's no wait time in the stream of the request/answer/request cycle. In the real world, users spend time between requests, reading returned information and typing in orders. So, for a given number of clients on these tests, the actual system load is equivalent to a much higher number of real-life users.

TECH FOCUS — DYNAMIC WEB PAGES

Doing Dynamic Data

A normal database server delivers query results to the user's terminal. Providing Web access requires one additional step: formatting the results in Hypertext Markup Language (HTML). From a browser, the user submits a uniform resource locator (URL) specifying either a script (to be executed on the server) or a file. For example, the following URL would request Microsoft's Internet Information Server (IIS) to execute a script: http://www.nstl.com/sample.idc. The results are returned directly to the server as HTML instead of being saved as files. Such HTML pages produced by script execution are called dynamic pages because their content can be different each time the script is executed. HTML pages stored in files are called static pages because their content doesn't change between requests unless an administrator or developer explicitly modifies the file.

Web database applications can use either static or dynamic pages. Any database programming tool can produce static pages by writing output to a text file with appropriate HTML formatting. Dynamic pages aren't so easy to produce. They require specialized applications that can accept requests from an Internet server, access a database, and return HTML directly.

Dynamic pages offer two capabilities not available in static pages. First, a script can query a database based on user-supplied selection criteria, which can differ each time. For example, the following URL requests the query.idc script to return only those records where the variable "state" contains the value CA: http://www.nstl.com/query.idc?state=CA.

A second capability of dynamic pages is data entry. A user can submit a request for a script that performs an insert or update operation rather than a query. Here the script must recognize the variables included in the URL as data with which to update the database. Many browsers allow the display of forms, which are HTML pages where users can enter information into fields. When the user finishes entering data, the system translates the information into a URL with variables, similar to the above example.

For a URL to initiate script processing, the Internet server must execute another program, pass information to it, and get information back. The Common Gateway Interface (CGI) is an API, supported by virtually all Internet servers, that allows interaction between an Internet server and an application. Unfortunately, CGI is notoriously slow, so many Internet servers provide their own, more efficient APIs. Microsoft IIS supports Internet Server API (ISAPI); WebSite Professional supports WebSite API (WSAPI); and Oracle Workgroup Server supports Web Request Broker (WRB). Most Internet-server database-access mechanisms use their own APIs, but Cold Fusion, used by WebSite Professional, is a CGI application.

OLE, Can You C . . . My Data Request

example, dbml.exe is the Cold Fusion CGI program, and query.dbm is the template, which also specifies the data source and the appropriate SQL to execute. The Cold Fusion CGI program initiates the Cold Fusion NT service (set up during software installation), which executes the database operation and then returns the formatted HTML to the Internet server.

Of these three products, WebSite Professional is the most versatile and the easiest to learn. The limited version of Cold Fusion bundled with the package limits its flexibility, but it offers a number of powerful features, including multiple query-result sets. ■

PRODUCT INFORMATION

Internet Information Server 1.0	WebServer 2.0	WebSite Professional 1.0	Live Wire Professional
Free via download; must run under NT Server	$2495	$499	$695
Microsoft Corp.	Oracle Corp.	O'Reilly & Associates, Inc.	Netscape Communications Corp.
Redmond, WA	Redwood Shores, CA	Sebastopol, CA	Mountain View, CA
(206) 882-8080	(415) 506-7000 fax: (415) 506-7200	(707) 829-0515 fax: (707) 829-0104	(415) 937-2555
http://www.microsoft.com	http://www.oracle.com	http://www.ora.com	http://home.netscape.com
Circle 1094 on Inquiry Card.	Circle 1095 on Inquiry Card.	Circle 1096 on Inquiry Card.	Circle 1097 on Inquiry Card.

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Evaluations in this report represent the judgment of BYTE editors, based in part on extensive tests conducted by NSTL, Inc., as documented in a recent issue of its monthly Software Digest *covering the Microsoft and Lotus suites. To buy a copy of that report, with its own evaluations and data, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE magazine and NSTL are both operating units of The McGraw-Hill Companies, Inc.*

Jon Udell

Web Project



Push Me, Pull You

How to combine e-mail push and Web pull with Next's WebObjects

Web protocols and e-mail together make a curious two-headed beast. Using e-mail, I can push data to your computer. Using the Web, you can pull data from mine.

Lately, I've noticed that people push a lot of big documents into my mailbox—documents that would be more useful to me if they were on the Web. Why mail them? It's not because the senders don't operate Web sites. Many do. But nothing alerts me to the appearance on those sites of new documents intended for me. Hence the use—or, I would say, the abuse—of e-mail.

In this month's column I'll describe a simple way to improve e-mail and Web synergy. It involves an extension of BYTE's Virtual Press Room (http://www.byte.com/vpr/vpr.htm). VPR streamlines communication between vendors and BYTE editors by enabling vendors (or their public-relations agents) to submit press releases and product descriptions directly to a searchable, navigable Web archive.

The problem with VPR's first incarnation was that editors had to log in and actively scan the archive. Once the novelty wore off, they didn't do that archive check on a regular basis. Should VPR, therefore, deliver its documents to editors as e-mail? No way! That would further overload mailboxes that are already groaning with broadcasted documents. Instead, I decided that VPR should use mail properly, to deliver messages rather than lengthy documents.

VPR Update, Version 1

The daily VPR update delivered to editors contains a summary of the latest batch of documents added to the archive, along with pointers (URLs) that lead to the documents themselves. Here's part of yesterday's update:

```
Company: TDK Systems, Inc.
Title: TDK Systems introduces
100Base TX LAN Card
URL: http://dev5.byte.com/vpr/
vpr1404.htm
```

The Perl script that produces these messages is straightforward. Some of the fields I wanted to include in the update were stored as META tags in the VPR header (see http://www.byte.com/art/9512/sec9/art1.htm). I'd already written a function to extract these fields in order to build views of the archive by company and product (see http://www.byte.com/art/vprtabs.pl). Other fields, such as Title and Summary, aren't stored in the VPR header. They're just sections of each VPR document. But since the script that writes these documents guarantees regular structure, these pseudo-fields are easily recoverable.

What makes VPR Update effective is that each update message includes a link to a complete document. Here's an example of how it can work. On February 29, Susan Nicolls submitted an announcement for General Magic's new Active Web Tools. On March 1, it appeared in BYTE editor Rex Baldazo's VPR update message. Intrigued, Baldazo clicked once to view the document. From there he clicked again on Nicolls' "mailto" URL (activated automatically by VPR) to acknowledge receipt of the document and request more details.

It would be great if things always worked this easily but, unfortunately, there's a catch. Baldazo had to be running the Netscape 2.0 mail client, which converts Web addresses in message texts into live, clickable links. Editors who receive VPR updates on their BIX or cc:Mail accounts miss out on these links. Of course, they can cut the Web address to the clipboard and paste it into a browser. But that's like getting up off the sofa to change channels on the TV. Life's too short. We demand instant gratification and, in this case, we should have it. Lotus Notes users take for granted the ability to mail doclinks to other users. It's a powerful technique that Internet users should be able to take for granted, too.

VPR Update, Version 2

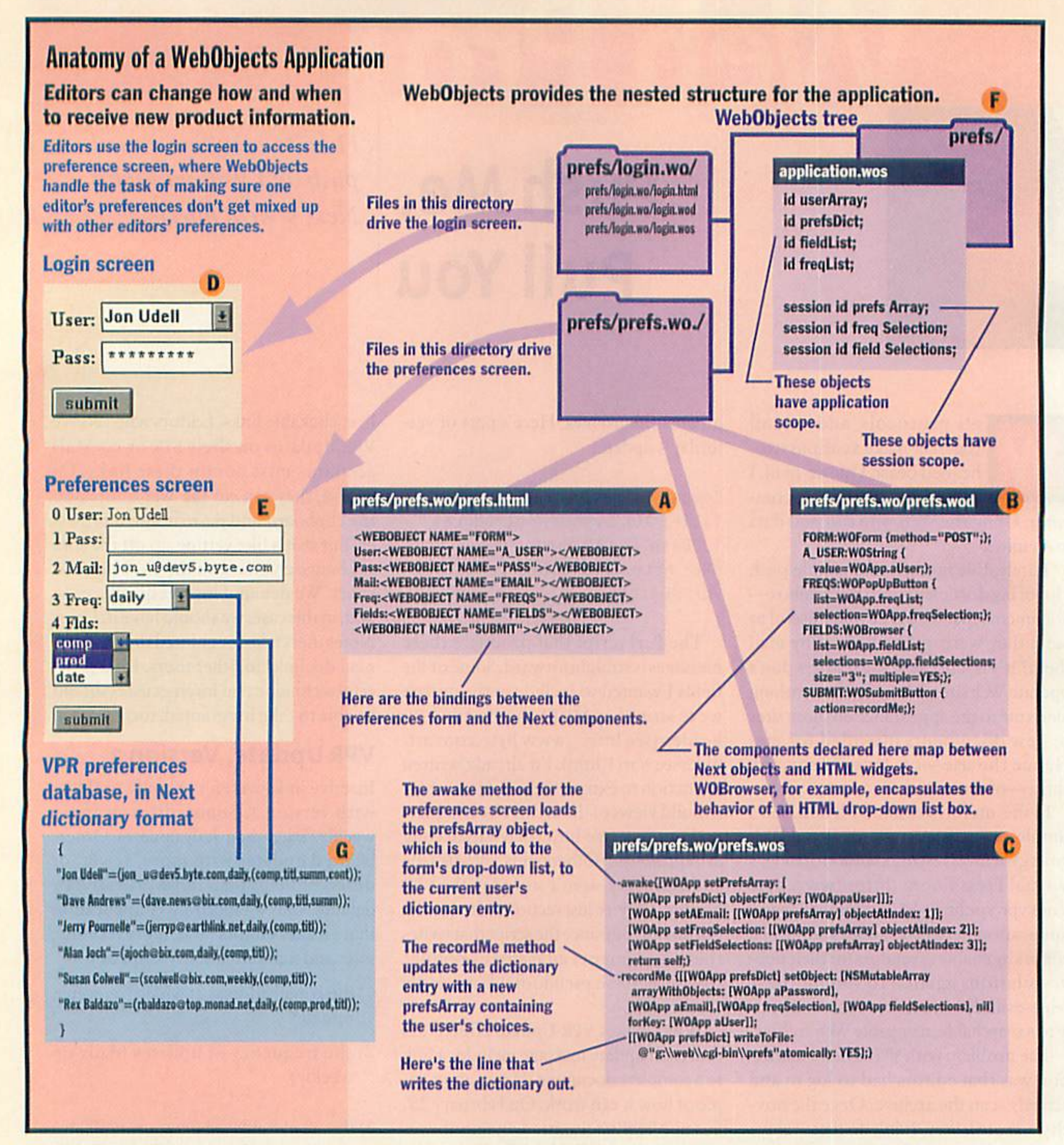
Inactive links weren't the only problem with version 1. Some editors wanted weekly rather than daily updates. Others wanted updates with more, fewer, or different fields than those provided by default. Thus was born a Web application that enables editors (and, more recently, sales and marketing staff) to specify:

1) the e-mail address at which to receive updates

2) the frequency of updates (daily or weekly)

3) the set of fields to be transmitted (i.e., Company, Product, Title, Date, Summary, Contact).

This application required a Hypertext Markup Language (HTML) form connected to a database of preferences. For the planned 20 to 50 users, that database didn't have to be anything fancier than yet another structured ASCII text file. Reading that file in Perl was trivial; it can easily absorb an ASCII representation of the necessary data structure, an associative array of lists containing lists. But unlike Lisp, Perl can't



How WebObjects manages VPR update preferences. Users can view and change their settings with a browser. Behind the scenes, HTML templates and Objective-C scripts drive the application.

natively write back a changed version of this structure in ASCII form.

Beyond Perl: Next's WebObjects

Of course, there are ways to make Perl structures persistent. In Unix, Perl can store flat associative arrays in DBM databases. For nested structures, which this application requires, Perl 5 modules implement persistence. But there's more to Web development than Perl. Here was the perfect opportunity to test-drive Next's WebObjects, which I'd recently downloaded from http://www.next.com. I've always liked Objective-C and the Next object libraries, but I never had a convenient way to deploy applications built with them. On the Web, Next's toolkit and many other software toolkits enjoy immediate mainstream applicability. The freedom is exhilarating.

WebObjects is available for Next, Solaris, and Windows NT (Intel only) platforms; I'm running it on NT. It works with a variety of Web servers; I'm using it with Microsoft's Internet Information Server. And it works with any browser because all the object intelligence lives on the server side. *continued*

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www.lotus.com

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BOOKNOTE



SQL for Smarties: Advanced SQL Programming

by Joe Celko ($39.95)

Morgan Kaufman
http://www.mkp.com

You can go a long way managing data with Perl, but eventually you have to break out a real database. When you do, here's an excellent, vendor-neutral refresher course on advanced SQL.

TOOLWATCH

CelAnimator ($249)
FutureWave Software
San Diego, CA
http://www.futurewave.com
From the maker of SmartSketch, the most intelligent paint/draw hybrid I've seen, comes a nifty tool that builds vector animations for the Web.

Like nearly all the toolkits that map database records to Web forms, WebObjects encodes the mapping using HTML templates (see A in the figure on the preceding page). Unlike many of the others, though, the WebObjects template language does not express logic such as "If Field1 > Field2 then output Field3." You encode higher-level behavior by declaring a set of Web components (see B in the figure) and writing an Objective-C script (see C in the figure) to manipulate those components.

Anatomy of a WebObjects Application

The flow of events in a WebObjects application begins when a user clicks on a URL like this:

```
www.byte.com/cgi-bin/WebObjects.exe?prefs
```

where `prefs` refers to a WebObjects directory tree containing templates, mapping files, and scripts. WebObjects.exe is a small, transient stub responsible only for sending a request to a daemon (Unix) or a process (NT) that implements the guts of an application. This stub-and-daemon architecture minimizes Common Gateway Interface (CGI) overhead. Furthermore, it makes even the humblest WebObjects application (like mine) inherently scalable.

Users log in to get to the preferences screen (see D and E in the figure). Since HTTP is stateless, how can the application avoid mixing up the preferences of one user with those of another? WebObjects handles this automatically by creating stateful sessions, stamping transactions within a session with HTTP cookies, or (for browsers that can't handle cookies) with hidden fields. To tap into this state management you need only declare objects, such as the preferences list, to have session-level—rather than application-level—scope (see F, the WebObjects tree, in the figure).

The components I used were the simplest kind: HTML intrinsics such as the password textbox and the drop-down list box. But the class library that supports WebObjects also provides fancier components, such as a calendar. These components, unlike their Java counterparts, require no extra client intelligence. Ultimately, the libraries render everything as HTML usable by any forms-capable browser. That's a refreshing echo of the Web's original simplicity and universality. Components can, meanwhile, enjoy the full benefit of object orientation. In a family of components related by inheritance, for example, changes in appearance and behavior propagate automatically.

Setting Your Preferences

On the preferences form, a user can change the e-mail address, the update frequency, and the list of fields included in the update. The declaration of the form component names the routine that's wired to the Submit button. That routine has access to the session object containing the current user's list of preferences and to the application object containing the dictionary of all users' preferences. A dictionary is the Next (and Smalltalk) equivalent of a Perl associative array—a set of name-value pairs. Two lines of Objective-C suffice to update the dictionary, then save it to disk (see G in the figure).

Saving the dictionary as a text file works fine for the few dozen current users. It clearly won't work fine for tens of thousands of users. This scenario isn't far-fetched, either. I'm planning a registration system for the BYTE Site, and personalized delivery of VPR updates will be one of the benefits that registered users enjoy. WebObjects Enterprise, the high-end commercial version of what Next gives away for free on the Web, was built for jobs like this one. It includes Next's Enterprise Objects Framework, which creates persistent mappings between objects (such as my preferences dictionary) and Sybase or Oracle data stores.

It would take more than one project to justify the $25,000 price tag for WebObjects Enterprise. And the midrange version, a $2500 product called WebObjects Pro, doesn't offer the same compelling abstraction of data management. So I'll probably end up with a different solution.

But even if I don't buy Next's toolkit, I absolutely buy into Next's development philosophy: True object-oriented business logic, mapped transparently to plain-vanilla HTML widgets on the front end and industrial-strength SQL storage on the back end. This server-centric model runs contrary to the client-oriented Java/ActiveX movement but, for right now and for the near future, this approach can deliver Web applications to a lot more users.

Finishing Touches

My WebObjects application only gets and sets preferences. Ideally it would create and send updates, too, but the free version of WebObjects can't call a mail program. You can link this capability into your application with WebObjects Pro, but for me it was easier to handle this chore in Perl. Scheduled to run daily and weekly, a script (http://www.byte.com/art/downloads/prefs.pl) parses the preferences file, extracts requested fields from VPR documents, creates update messages, and sends them.

The final result is a hybrid application: half Perl, half Objective-C. It's a hybrid in another sense, too: half e-mail, half Web. I think the world needs more of these. Consider list servers. It's feast or famine: either too much information or none. A hybrid push/pull approach would be so much nicer. I'd still receive timely updates, but I could drill down for details on my own terms.

Next time you want to e-mail me a hefty document, do us both a favor. Just mail me a pointer. ■

Jon Udell (judell@bix.com) *is BYTE's executive editor for new media.*



Telecom Gets Wild

Who will be best equipped to deliver tomorrow's digital networks? Consider today's road maps for merging data, voice, and video.

Convergence Strategies

An any-to-any global network is a compelling idea. When will we overcome the complex technical hurdles that stand in the way of making it real?

Page 123

Data's New Voice

Voice/data integration continues to get a push from real-time audio technologies and new telecommunications standards.

Page 129

Global Video Village

Three broadband technologies bring us a step closer to making video over global networks practical.

Page 137

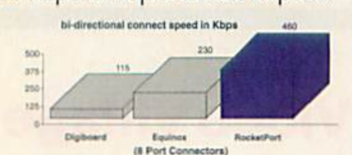
WHAT DO LOCKHEED AND THE WEATHER CHANNEL HAVE IN COMMON?

THEY USE THE HIGHEST PERFORMING MULTIPORT COMMUNICATIONS BOARD IN THE INDUSTRY!

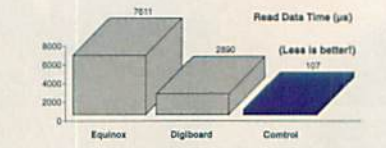
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Convergence Strategies

Although any-to-any digital networking is still a pipe dream, there are any number of ways to start filling the pipe.

By Larry Yokell

Listen to telecommunications companies and you might think that convergence is as easy as a game of connect the dots. Sketch out lines to the right end points and presto!—you have a digital data network that seamlessly integrates text, voice, and video traffic.

The dream of convergence is alluring, but reality ruins everything. Any-to-any digital networking is complex because it must accommodate a host of legacy and leading-edge technologies. Once you interconnect protocols and network layers—no easy feat—you have to make end-user applications ready for a single, global network. And what thorny technical problem would be complete without an Internet element? Will the Net be the golden cornucopia for any-to-any networking? Or will it collapse under the weight of its own success, as cynical experts have suggested? To understand the technological challenges of establishing any-to-any digital networks, let's look at these hurdles one by one.

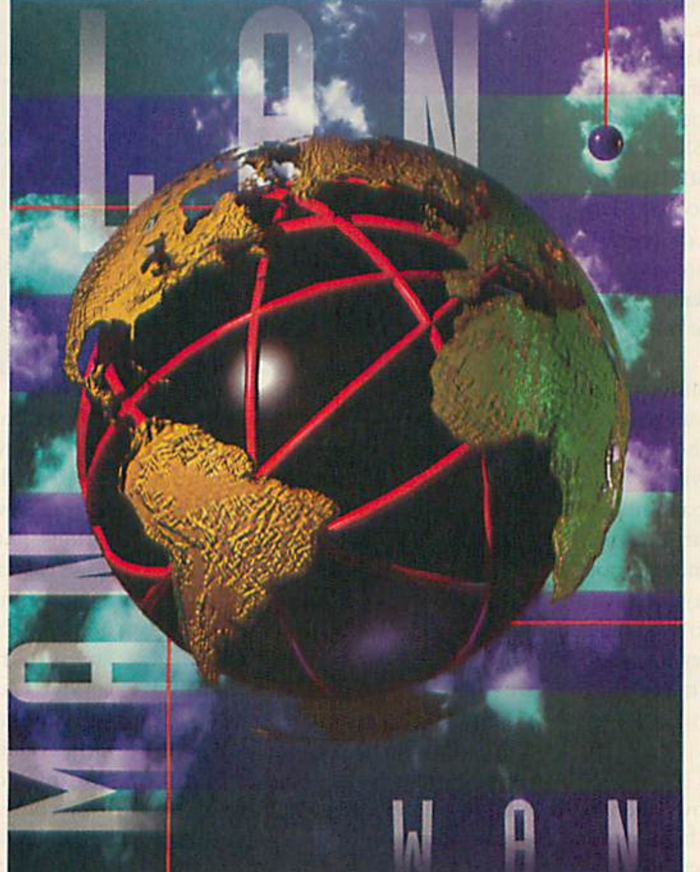


ILLUSTRATION: ROY WIEMANN © 1996

Puzzle Pieces

What technologies have to converge to make any-to-any networking a reality? Start from the top with advanced backbone platforms like synchronous optical network (SONET), asynchronous transfer mode (ATM), and Switched Multi-megabit Data Service (SMDS). Add to this relative newcomers to network access like ISDN, asymmetrical digital subscriber line (ADSL), and frame relay. Traditional technologies are part of the convergence puzzle, too, so you have to factor in networking standbys like X.25, T1, Systems Network Architecture (SNA), and dial-up networks over private telephone lines.

Like the Wizard of Oz, who ruled the land as that man behind the curtain, data networking providers—from telcos to long-distance carriers, Internet service providers (ISPs), cable TV operators, and systems integrators—must work under the covers to solve the complexities of interconnecting numerous backbone and access technologies. Corporations working out an any-to-any networking plan will find as many strategies as there are data networking providers, which means that the ultimate solution will probably be a mix of technologies. What's more, the right mix for businesses will probably be different than what's used in homes. In the latter, everything from plain old telephone service, Basic Rate Interface (BRI) ISDN, ADSL, hybrid fiber coax (HFC), cable modems, and switched digital video (SDV) will play roles.

In the business world, "clear channel" TCP/IP using 56-Kbps or T1 facilities, frame relay, and Primary Rate Interface (PRI) ISDN will initially dominate, says Dave Schriftgiesser, broadband networking director for Lucent Technologies, a designer of communications systems and software (and formerly known as AT&T Network Systems). "As ADSL and cable modems come on-line, they will overwhelm frame relay's capacities and we'll be migrating to ATM," he adds.

For corporate customers, "full service" is the message being heard from data-networking providers. The list of offerings includes voice, video, and data services via wireline telephony, personal communications services, videoconferencing, cable

TV networks, digital near video on demand (NVOD), and high-speed access to the Internet. In some cases, these services will be regional; in others, they will be national.

For example, Bell Atlantic, which is in the process of merging with fellow Baby Bell Nynex, offers All@once, a package of data networking products that use SMDS, FDDI, ATM/cell relay, frame relay, and multiple dedicated private connections. Bell Atlantic also plans to eventually deploy a network that has a switched digital video backbone with the final thousand feet consisting of ADSL over twisted-pair connections. "Our long-term vision is to deploy a complete end-to-end ATM solution," according to Bill Lawrence, vice president of network systems engineering for Bell Atlantic. "However, ATM is still in its infancy, and we don't have a big enough fiber backbone in place to support it at this point," he says.

For the near term, Bell Atlantic is concentrating on "in region" data networking solutions, where customers typically have frame relay and/or SMDS at the ends of their networks. "ISDN is more problematic, but we pop out into an SMDS cloud and then we convert as needed to other access technologies. For the most part, we try to persuade our customers to direct-connect to our SMDS network," Lawrence says.

The U.S. Federal Communications Commission is working on a variety of regulations that will affect how RBOCs provide data networking services. "Right now, we are still required to pass our data transport to long-distance carriers when we cross LATA [local access and transport area] lines," Lawrence says. "In the future, we expect the FCC to drop these restrictions, and when they do, we'll revise our data networking model."

Convergence Do's and Don'ts

Until data networking providers work out the technical and business details of any-to-any digital networking, flexibility should be the watchword of your convergence strategy. Data networking integrator Don Cleavinger, chief technologist for EDS's communications group, suggests five ways to help manage change.

- Focus on the long term. Your main criteria in choosing data networking technologies should be cost effectiveness and ability to accommodate evolutionary rather than revolutionary change.
- Plot a course and stick with it. Don't lurch from technology to technology just because you happen to read about something new. "Some managers decide they need frame relay immediately, even if they don't really know what it is" or how it might benefit their company.
- Don't expect a quick fix from any technology. "Customers often apply new technologies to their existing business processes and obtain mixed results. You must change your business processes to take advantage of new technologies."
- Invest in ATM to the desktop. If you've prepared your business for fundamental change, don't hold back making the move to ATM. ATM will help you cope with customer expectations for network performance. "People who want Microsoft Exchange to operate within 10-Mbps Ethernet today will want 100BaseT the year after that. The year after that, 100BaseT won't be adequate. In contrast, ATM to the desktop should satisfy customer demands for the next five years. Furthermore, if you put in ATM to the desktop, you won't have to change the wire-closet switching fabric."
- Take matters into your own hands when necessary. Many tariffed carrier data services are either too high-priced or inconvenient from a customer perspective, which leads companies like EDS to build a private ATM network to service its customers. "Carriers like AT&T and MCI will accept only 53-byte cells [ATM data packets] from their customers, no exceptions. Therefore, customers are required to do all data conversions prior to accessing the network. On a scaled basis, it might cost me $4.60 to adapt my SNA and frame relay traffic to the DS-3 format required by a carrier to connect to their tariffed ATM backbone. [It would cost] $1 if I had stayed with plain old DS-3."

Life at the Application Layer

How can you protect your investment in LANs? MCI and other carriers hope to provide services that help internetwork legacy systems, like SNA networks, and migrate them from a host-based design to a client/server architecture.

Any experienced MIS director appreciates the pain involved in installing a LAN and the affects it has on end-user applications. The problem becomes magnified as more corporate LANs are interconnected to WANs and metropolitan-area networks (MANs). "From a wide-area networking perspective, we'll reach nirvana when our network evolves to a campus-like environment and applications are transparent," says Steve Starliper, vice president of marketing for !Nterprise Networking Services, a division of US West Communications and a provider of LAN interconnection and ATM backbone services.

The !Nterprise strategy is to move beyond providing customers with a "dumb" bit pipe. Many telcos provide services between Layers One through Three (the physical, data link, and network layers, respectively, of the Open Systems Interconnection reference model). !Nterprise creators are focusing further up the protocol stack to Layer Seven, where applications for such things as e-mail, file transfers, and transactions reside. !Nteract could achieve applications transparency by bundling bandwidth and application offerings. This is a new strategy for data-networking providers, who typically assume customers will provide their own applications. !Nteract uses Microsoft's Windows NT and BackOffice Server suite as its operating platform and incorporates Netscape's Navigator for "plug-in" access to the Internet. In addition, the service uses Cisco Systems' internetworking platform and protocol support. Other value-added services include Web hosting, groupware via Lotus Notes, local content, fax, forms management, vertical market applications, and transaction processing.

The strategy sounds good, but data networking providers haven't proven they can deliver on the promise. This approach requires providers to do some software engineering. Nevertheless, some people believe that an !Nterprise-like plan is the best hope for any-to-any digital data networking. "The carriers

[must] break down walls and move up the value chain toward providing systems integration services," says Don Cleavinger, chief technologist for EDS's communications group, a data networking integrator. "Any carriers that stay in the commodity business of providing bandwidth and cheaper T1 service will be missing the boat. Others that move up the chain will have a role to play [in digital internetworking]."

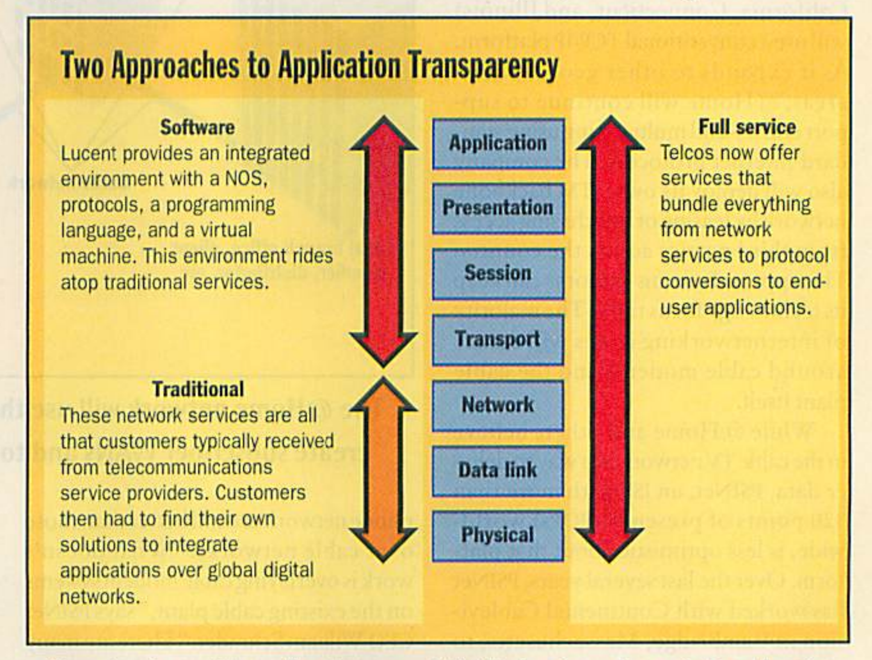
MCI recognizes the potential of this strategy but doesn't implement it to the extent that !Nterprise advocates. MCI services handle Layer Two protocol conversions, but the company expects customers to take care of Layer Three conversions (e.g., IP to IPX). To make this transition, MCI in part will use routers to connect customers to its SMDS or frame relay services. But the company cautions that merging legacy systems into a client/server architecture isn't for those who need instant gratification. "On a big network, executing a transformation plan can take up to a year, especially if Layer Three internetworking is required," says Steve Tabaska, MCI vice president for data services engineering.

MCI expects to move from today's separate networks to an integrated router scheme that supports multiple protocols to achieve internetworking. "In effect, we're trying to create an integrated router from a LAN environment, and then evolve the LAN into an integrated WAN router environment," Tabaska says. For example, MCI offers X.25, ISDN, frame relay, SMDS, IP, and ATM services. Some of these can be internetworked, while others cannot. "ISDN is really a Layer One service; X.25, frame relay, SMDS, and ATM are Layer Two; and IP is Layer Three," Tabaska says.

Currently, MCI supports seven combinations of internetworking for its services, including dial-up to X.25; ISDN to X.25, frame relay, and IP; and frame relay to X.25, IP, and ATM. MCI does not support dial-up and ISDN access connections to SMDS and ATM, or frame relay to SMDS, among others. "Evolving a complete internetworking plan for MCI's offerings will take two years to put in place," Tabaska says.

Sprint's answer to internetworking is ATM to IP and ATM to frame relay, according to Cathy Gadecki, group manager for ATM services. The company plans to bring on-line next year a pure ATM backbone for all frame relay and IP end points. "We'll be pushing out the frame relay backbone to the network edges and then phasing out our frame relay backbone," Gadecki says.

In its current circuit-switched network, Sprint uses either ISDN or Switched 56 services to provide access to its frame relay network. "In the near future, ISDN will become an access technology as well as a backbone," according to Gadecki.



New tools meld applications and digital networks as telcos begin offering more than bandwidth.

Sprint has no intention of missing the "full service" boat. From a transport point of view, cost effective and easy-to-use ISDN, ATM, frame relay, and IP will be key enablers. "Sprint plans to complement our transport capabilities by providing managed network services, bundling in CPE [customer premises equipment] offerings, providing IP security services, as well as other Internet and intranet services," says Gadecki.

While telcos want you to look no further than their product brochures for ways to integrate applications, some competitors are building software tools to help you turn convergence cacophony into harmony. Lucent recently announced a software platform, called Inferno, that could provide applications transparency on any-to-any data networks. "It's the client/server multimedia equivalent of dial tone," Schriftgiesser says. "Inferno relates to the signaling networks of today and will provide signaling for the transaction-oriented point-and-click world as well."

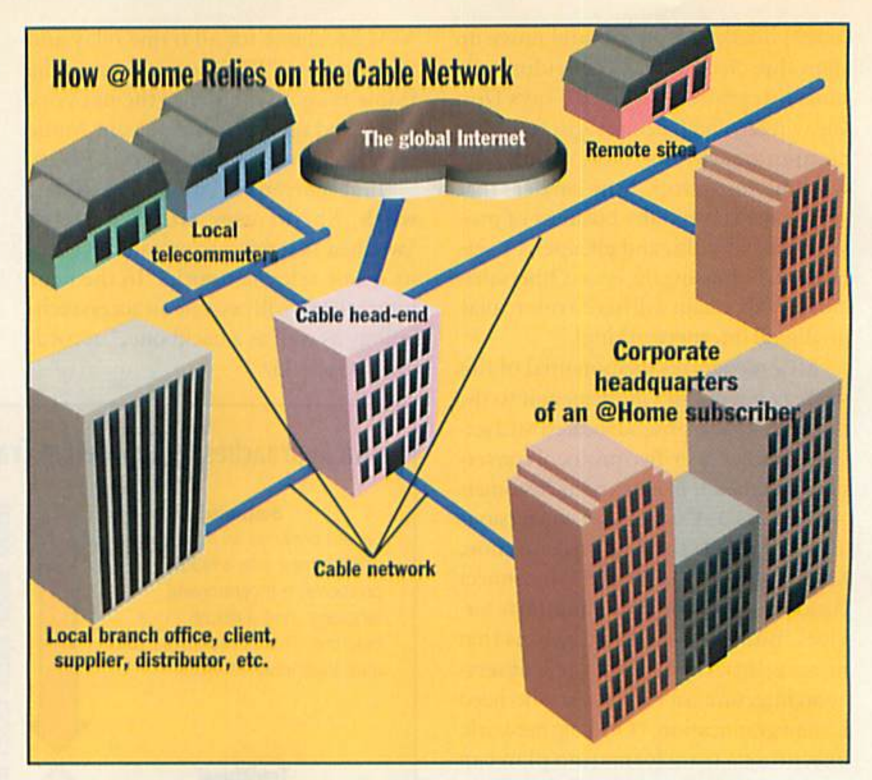
Inferno consists of a network operating system; communications protocols, called Styx; a network API; a programming language called Limbo; and a virtual machine called Dis. Lucent will license Inferno to service providers, telephone and cable companies, applications developers, and content providers. Inferno may even find a home in Internet terminals, hand-held devices, advanced telephones, and set-top boxes.

The Network Is the Home

On the residential side of digital networking, Time Warner's estimated $50 million interactive cable TV system in Orlando, Florida, called the Full Service Network (FSN), has become one of the most notorious examples of voice, video, and data services. Using a 1-GHz HFC network, FSN incorporated an ATM-to-the-home scheme that required a massive systems integration effort and more lines of code than the first Apollo moon shot. The project has logged several delays and substantial cost overruns. By early 1996, the service had more than 4000 subscribers, but the estimated cost of the network was more than $10,000 per subscriber. *continued*

Because of these mixed results, other companies are taking a more modest approach to the residential market. @Home, a provider of high-speed Internet access and on-line content, uses cable modems exclusively and departs from the conventional wisdom of offering a wide variety of access methods to the Internet. By 1998, @Home (cofounded by cable giant TCI) hopes to reach one million subscribers using this strategy.

The @Home network (in parts of California, Connecticut, and Illinois) will use a conventional TCP/IP platform. As it expands to other geographical areas, @Home will continue to support end-to-end multicasting using standard Internet protocols. The company also will deploy its own ATM backbone network by leasing or purchasing access from third parties across the country. This approach means @Home can keep its technology focus tight: The majority of internetworking issues will center around cable modems and the cable plant itself.



The @Home network will use the cable plumbing exclusively to create subscriber WANs and to provide Internet connections.

While @Home and others believe in the cable TV network as a way to deliver data, PSINet, an ISP with more than 320 points of presence (POPs) worldwide, is less optimistic about that platform. Over the last several years, PSINet has worked with Continental Cablevision in Cambridge, Massachusetts, to test high-speed Internet access via cable modems. The trial proves that cable modem hardware works, PSINet says, but Internet connections over the telephone network are still better than those over cable networks. "What doesn't work is overlaying cable modem systems on the existing cable plant," says PSINet CEO William Schrader. "There are many problems with upgrading this plant to provide two-way capabilities and to eliminate noise that makes data connections unreliable. We believe it is better, cheaper, and faster to use the telephone plant."

Internet Dominance

At the heart of any-to-any internetworking is a debate over backbones. On one side are those people betting network backbones of the future will be based on an ATM switched platform. Others see the Internet's IP-routed platform providing a glimpse of the future.

"The common denominator for any-to-any digital data networking is the Internet, and the common denominator for the Internet is IP," says Ron Vidal, MFS Communications' vice president of new ventures. "In fact, true any-to-any data networking is fostered by the Internet because IP can reside in a client, server, or any other device."

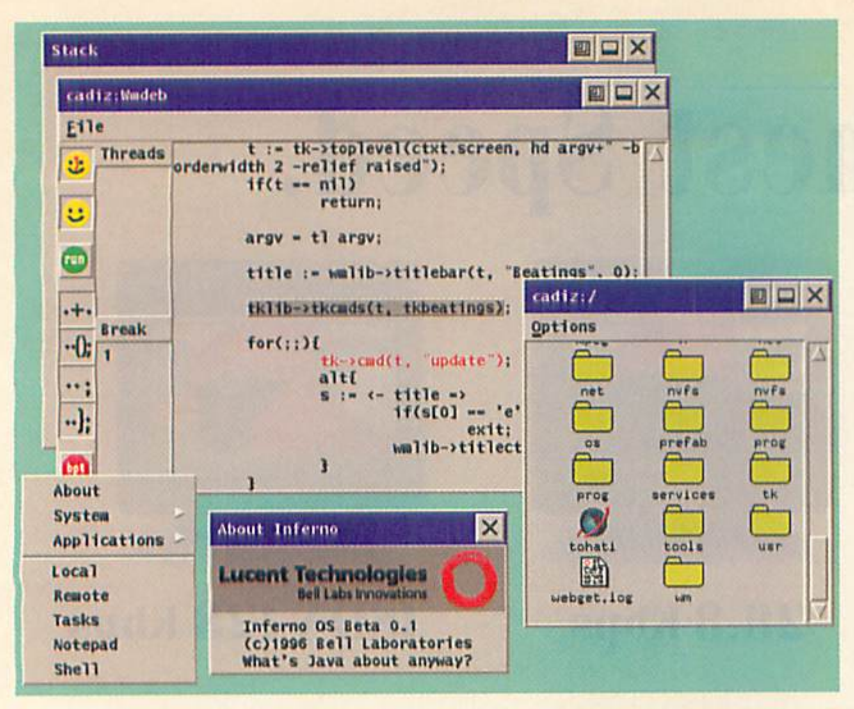
MFS, a competitive access provider, jumped on the Internet bandwagon when it merged with Internet service provider UUNET Technologies earlier this year. The combined company is the only ISP (out of about 2500 in the U.S.) to own or control fiber-loop, intercity, and underseas facilities in the U.S. and parts of Europe. This international platform interconnects 543 Internet POPs, including 288 outside the U.S. *continued*

No Shortage of Standards

As a computer wag once said, the nice thing about standards is there are so many to choose from. Datacom standards are no exception. For example, in the emerging market for cable modems, no less than six standards bodies are involved, including the Institute for Electronic and Electrical Engineering (IEEE)'s 802.14 Working Group, the Digital Audio-Visual Council (DAVIC), the ATM Forum's Residential Broadband Group, the Moving Pictures Experts Group (MPEG), the Internet Engineering Task Force (IETF), and the International Telecommunications Union (ITU).

From the standpoint of any-to-any digital data networking, the key will be standards, such as TCP/IP and ATM, that can be effectively internetworked. "Will TCP/IP always be the king or will ATM eventually make it to the desktop?" Bill Lawrence, vice president of network systems engineering for Bell Atlantic, asks. "While there is equipment available that can encapsulate TCP/IP on ATM, this becomes problematic because most existing end devices support TCP/IP connectivity, not ATM."

Today, we're also seeing equipment that encapsulates ATM packets within TCP/IP, a concept known as cells in frames.



Lucent designed Inferno as a development environment for a range of users, including telcos, ISVs, and content providers.

MFS is bullish on the Internet in part because it is much cheaper than alternatives. For example, the cost to deliver a 42-page document between New York and Tokyo via the Internet can be as low as 2.8 cents—versus $28.83 over an AT&T phone connection during peak times. The Internet is more cost-effective than circuit-switched networks because optical technology has made transmission capacity relatively inexpensive and because IP packet switching uses transmission capacity more efficiently than circuit switching does.

"Also, I can make a good case for analog-to-IP connectivity when we're talking about Internet phones," Vidal says. "It's conceivable that people will even start designing PBXes to connect to packet-switched IP networks. Maybe the Internet starts looking more like a phone network at the physical routing level."

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MFS plans to offer Internet services ranging from metro-area exchange connections to local and national backbone access. "In our 'Internet hotel' concept, a customer can colocate a server at our central office and obtain the capability to increase the speed of a 56-Kbps connection to a T1 connection in a matter of hours," Vidal explains. "In contrast, the telcos are not willing to do this."

Businesses can set up even more sophisticated networks on intranets than on the Internet because intranets typically have more bandwidth available than dial-up connections, according to Vidal. Therefore, he believes, intranets can handle larger files and more complex graphics at higher speeds. "Ultimately, the LAN-to-LAN connectivity business will become an intranet business," Vidal predicts.

PSINet is also an unabashed booster of the Internet as the any-to-any networking platform. "The Internet scales well and it's ubiquitous" says Mitchell Levinn, PSINet's vice president of network operations.

"Ninety percent of all computer programmers on the face of the earth are working on internetworking applications," says PSINet CEO William Schrader. "Data movement of all types is being carried over TCP/IP networks. In the future, we can look forward to TCP/IP riding on an ATM network or SONET OC-12. In five years, we'll see TCP/IP packets riding over ATM to the desktop."

However, the Net's popularity is why other companies aren't putting all their packets in one basket. Internet traffic is getting so heavy that some people are predicting that the Net will begin to crash under its own weight later this year. While not going this far, Lucent's Schriftgiesser acknowledges there are "brownouts" on the Internet. He contends that the costs and benefits of providing additional capacity are so dispersed that people aren't motivated to really do anything about it. "The current telecommunications infrastructure is built around voice calls that require relatively short [connection] times," Schriftgiesser says. "Meanwhile, heavy Internet usage and browsing involve relatively long [connection] times and are thus loading down the telecommunications infrastructure. This leaves carriers trying to position for the future, while attempting to fix problems within their current systems."

Digital Future

All the empirical evidence points to an evolving telecom world in which data communications internetworking and any-to-any connectivity are essential within companies and among enterprise networks. While data networking carriers and equipment providers acknowledge the importance of any-to-any connectivity and promote their own visions for making it happen, few of them will admit that providing it to their customers is easier said than done.

Any-to-any digital data networking will become ubiquitous, global, and a vital part of communications. However, convergence may take the rest of the decade, cost more time and money, and cause more headaches than even savvy data communications professionals anticipate. But when we look back from the perspective of 2006, most of the challenges discussed here will probably have been met, and we'll remember convergence's technical hurdles as nothing more than growing pains. ■

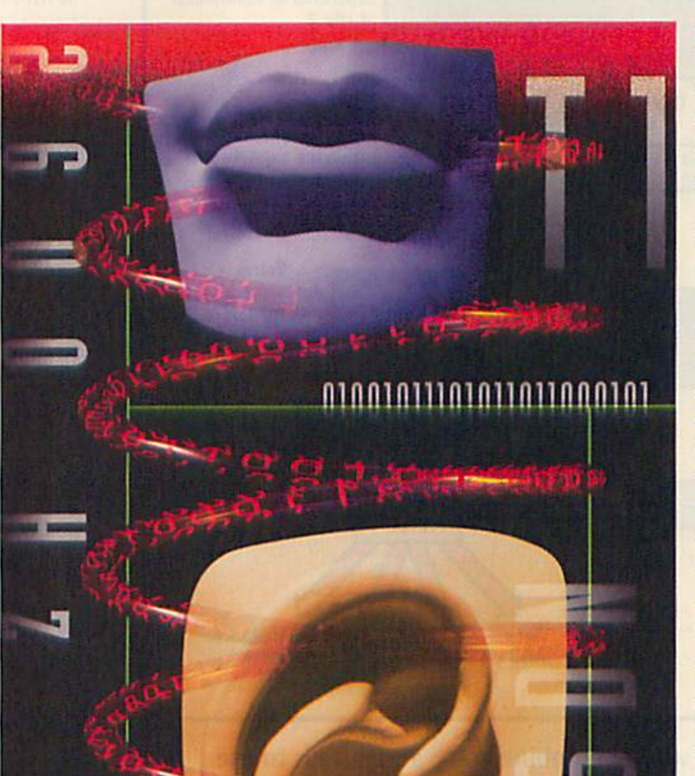
Larry Yokell is a telecommunications consultant and president of Convergence Industry Associates. You can reach him at **ljycia2@aol.com.**

Data's New Voice

Real-time voice technologies for the Internet and new telecommunications standards for integrated multimedia transmissions say a lot about convergence.

By Stanford Diehl

Two heads may be better than one for brainstorming sessions, but when it comes to managing voice and data traffic, nothing beats the simplicity of having a single pipeline for both types of data. So what's been keeping the rise of combined voice and data networks on hold for so long? The biggest challenge to voice/data integration has been the analog nature of traditional voice transmissions. But that's changing. Telephone networks have migrated to digital infrastructures, and, with the digitization of voice communications and the advancement of compression algorithms, multiplexing equipment, broadband transport interfaces, and switching fabric, the integrated voice/data network is finally taking shape.



This means that some pioneering companies can already take advantage of voice/data convergence. The good news for the rest of us is that the digital infrastructure in the public-switched telephone network is leading the way for larger-scale deployment of voice/data networks. What's more, deregulation of the communications industry is sparking some heavy investment from telecommunications companies (telcos) in advanced digital links and enabling equipment, and international standards are replacing short-term proprietary solutions.

Two Masters

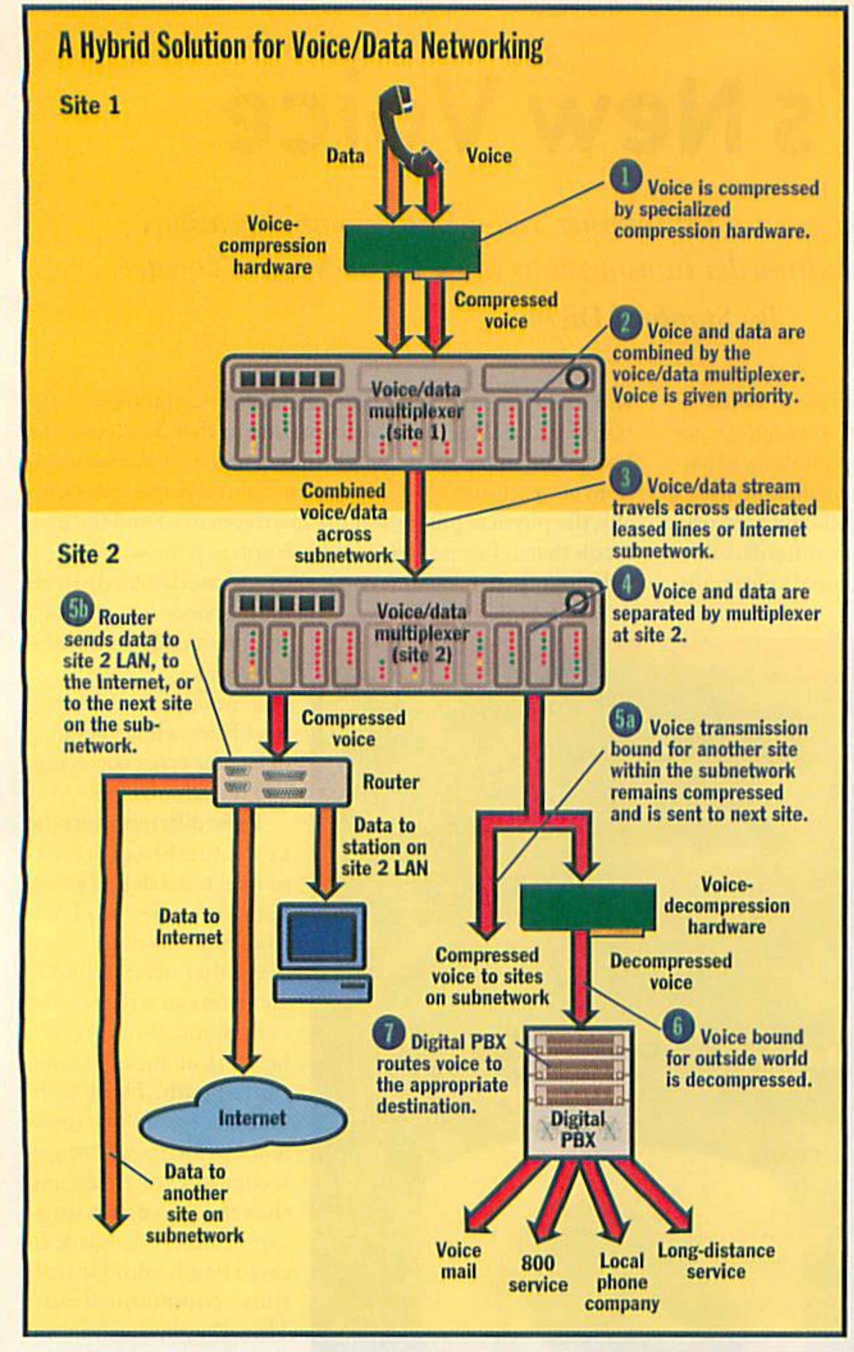
Telephone networks and LANs have traditionally served two different masters. To accommodate voice transmissions, a phone system is connection-oriented; when you place a phone call, you establish a dedicated end-to-end connection before the transmission proceeds. Once the system allocates bandwidth, the resource remains available for the duration of the transmission. The two main components that determine the bandwidth, robustness, and flexibility of the telecommunications network are the broadband transport technologies (actually, the physical piping and the interfaces to it) and the protocols that define packet transmission across the wire.

In contrast to telephone networks, LANs are designed to handle the bursty (i.e., variable-rate) nature of data transmissions. Arbitration schemes ensure the integrity of data while tolerating delays for error correction and retransmissions.

These differences are the key stumbling blocks to integrated digital voice/data networks. For LANs to support voice transmissions, they need technologies that can stream voice communications across a network along an uninterrupted path. These technologies ensure that a network prioritizes data and recognizes voice data and that the voice transmission receives enough dedicated bandwidth for real-time communications. Thus, the physical link and the transport mechanism must be able to differentiate among different multimedia types and support a wide range of transmission requirements.

Traditional voice networks, on the other hand, must support standardized high-bandwidth interfaces to the emerging fiber infrastructure as well as modern transport protocols that can handle the large transfer of variable-rate data. Voice networks must also differentiate among different multimedia types and share bandwidth that was once dedicated to voice.

As it turns out, the requirements of voice and data transmissions actually complement each other, as long as the pro-



One established way to combine voice and data is to use multiplexers, which create separate paths at the receiving end.

tocols properly handle the different media types. For example, sophisticated voice/data multiplexers can combine voice and data streams while granting priority to real-time voice transmission and dynamically allocating dedicated bandwidth to it.

For variable-rate transfer, a multiplexer can send data packets during lulls in a conversation. Variable-rate data, with its tolerance for interruptions, can consume open bandwidth when available and surrender bandwidth when necessary. Some companies are integrating voice/data multiplexers with dedicated T1 lines and Internet subnetworks (see the figure "A Hybrid Solution for Voice/Data Networking" above).

Technologies for the Internet and the public-switched telephone network also look promising. Some of the best examples are the new audio technologies (for streaming real-time audio across Internet connections) that make Web phones possible (see the text box "Yet Another Web Phenomenon" on page 132).

Digital Solutions

The above examples represent ways to combine voice and data using today's infrastructure and technologies. However, the public-switched telephone network continues to evolve. Telcos and others are improving the network with standards for fast packet switching and for interfacing to fiber-optic cable. New cell-relay transport protocols, such as asynchronous transfer mode (ATM), not only support higher transmission speeds but also include mechanisms for differentiating multimedia traffic, including voice, data, and video.

While fiber-optic is the high-speed link of choice, it's also helping to stall the development of integrated digital networks. High-speed fiber requires electrical-to-optical signal conversion. Asynchronous transmission services, such as T3, define a standard electrical interface but do not support a standard optical interface. The result is a number of proprietary interfaces to optical cables and little interoperability.

The answer to the confusing array of nonstandard asynchronous interfaces appears to be SONET. This standard specifies an electrical and an optical interface, enabling an interoperable delivery vehicle for broadband services.

The SONET standard is now in the third phase of its three-phase release. Earlier this year, major SONET vendors, such as Alcatel and Fujitsu, announced the third-party corroboration of interoperable SONET products from different manufacturers. Within the next few years, SONET should finally drive the development of an interoperable, all-digital multimedia infrastructure.

ISDN provides a fast voice/data pathway to the home or office. ISDN standards currently provide for high- and medium-speed digital links. Basic rate service, also called 2B+D or Basic Rate Interface (BRI), provides two 64-Kbps channels for voice or data, plus one slower, 16-Kbps data channel. Primary rate service, also called 23B+D or Primary Rate Interface (PRI), carries 23 64-Kbps channels and one 16-Kbps channel. It's no coincidence that the number of chan-

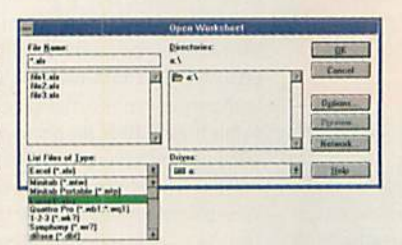


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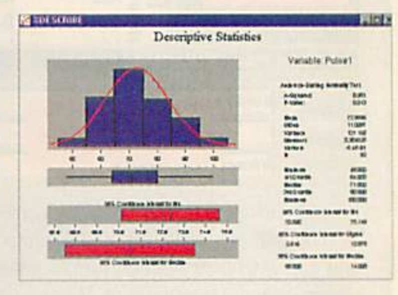
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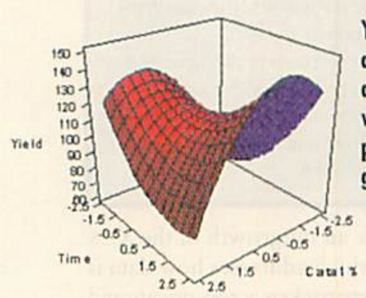
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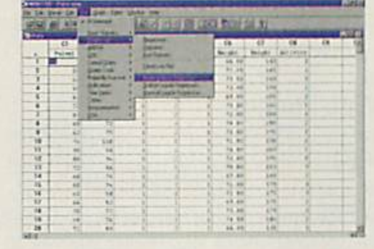


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Yet Another Web Phenomenon

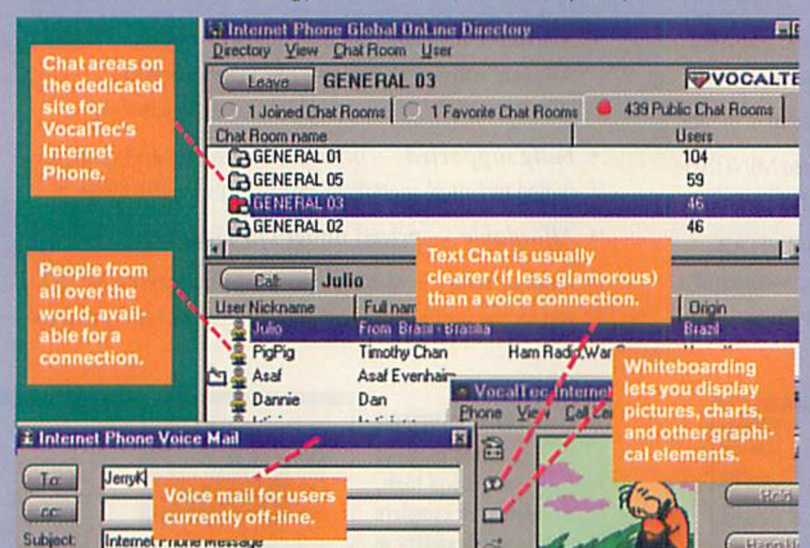
With the emergence of Web phones, the advantage of integrating voice and data networks has become strikingly obvious. Most everyone can grasp the concept of unlimited long-distance telephone service at a single, fixed rate. The Web-phone phenomenon is yet another example of how the Internet has brought an idea that's been around for a while—in this case, voice/data convergence—into the limelight.

The first hurdle to overcome in delivering real-time audio across the Internet is establishing an uninterrupted, constant-rate connection. New technologies from Progressive Networks and VocalTec bring streaming audio to the Web.

The most common technology so far is Progressive Networks' RealAudio. The company adopted the proprietary RealAudio protocol and a client/server architecture to enable streaming audio transmissions. The new protocol supports bidirectional communications (the HTTP protocol was designed for one-way continuous transmission) between clients and servers. This two-way pipe lets you pause, fast-forward, and rewind RealAudio tracks.

To stream data, RealAudio uses the UDP protocol over TCP. A socket-oriented protocol, TCP requires a great deal of overhead to manage sockets and ensure the error-free delivery of data. UDP is packet-oriented and does not guarantee error-free transmission. Without the overhead of TCP, UDP can deliver a continuous stream of audio data most of the time. RealAudio includes a loss-correction algorithm for re-creating any pieces of the signal that UDP drops.

Because UDP drives packets across the Internet without data-flow control or a fairness mechanism for resolving bandwidth conflicts, it can cause severe network congestion, especially if a server broadcasts audio streams to many users simultaneously (which is, after all, one of the obvious applications of streaming audio). Other audio-on-demand technologies, including I-Wave from VocalTec, use standard TCP/IP as the transport layer. With its flow-control mechanisms, TCP/IP can help avoid traffic congestion over the Internet. But streaming audio with TCP/IP doesn't retain an uninterrupted transmission as effectively as a UDP-based mechanism does.



Web Phones

Web telephony, while intriguing, suffers from sluggish Internet access (especially when used on slow dial-up connections); proprietary connection protocols and codecs (i.e., compression/decompression algorithms); dynamic IP addressing, which can foil the routing mechanism of Web phones; and the large installed base of half-duplex sound cards.

As you talk into a Web phone, your voice is digitized by the software and sent out across the Internet in data packets. Many packages, such as VocalTec's best-selling Internet Phone (see the screen), use bandwidth-limited UDP for real-time conversations. Since transmissions move from client to client, congestion is not as severe as it is with UDP transmissions from a central location to multiple clients.

Web-phone software uses IP addresses to connect to the remote party. Since expecting the caller to know the IP address of the called party is not reasonable, most packages let you connect by designating the party's e-mail address. The software associates this address to an IP address.

But many Internet service providers (ISPs) don't give customers dedicated IP addresses; instead, they often assign addresses on the fly. Under this scenario, a Web-phone call would be routed to the wrong address. Some vendors avoid this problem by establishing dedicated servers. The software logs you on to the server and maintains a directory of users. This scheme compromises privacy somewhat because names are listed on the directory; as a result, users may receive unsolicited calls.

To compensate for the bandwidth limitations of the Internet, Web phones compress voice data before sending it. The recipient of a call must then decompress the data at the other end. At present, there is no standard Web-phone codec; both parties must use the same Web software to talk to each other. The programs also use proprietary connection protocols. Currently there isn't much movement toward standardizing on Web-phone codecs and connection protocols. For now, you and your associates have to use the same software package.

Recent developments may help further the acceptance of Web phones. Many sound-card manufacturers have introduced full-duplex cards that allow two-way simultaneous Web-phone conversations.

Perhaps the biggest boon to all types of real-time audio over the Internet will be when higher-speed connections, such as ISDN, become more prevalent and a higher-bandwidth infrastructure is established.

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nels and data rates for these ISDN standards is close to the number required for T1; these standards are designed to be interfaced to T1 equipment at the central office.

But deployment of ISDN has been slow everywhere except in urban areas, and business data connections over ISDN are not "flat-rate," as are leased-line and Internet connections. This has caused many once-eager customers to receive unexpectedly high bills.

A Pickle over Packets

So-called fast-packet technologies, such as frame relay and cell relay, might offer the best solution for integrated voice/data networks. These fast-packet technologies are an outgrowth of the X.25 standard, which addresses how data is sent in discrete packets across private and public networks.

Real-time isochronous applications work best with smaller packets that reduce bottlenecks and avoid interruptions in the transmission stream. LAN transports have traditionally supported larger

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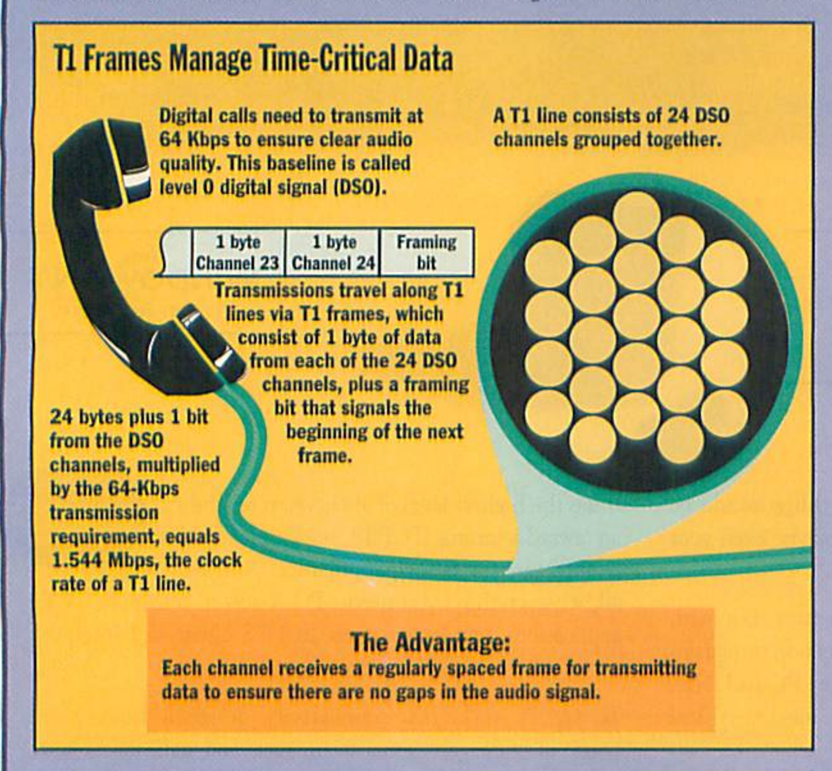
Bell Labs' digital architecture still underlies most private networks as well as the Internet. The system is based on the concept of time-division multiplexing, a scheme in which bytes from different data connections or telephone conversations are alternated so that each one is guaranteed a certain fraction of the bandwidth.

Here's how the system (formally called the Bell System digital hierarchy) works. To carry each half of a conversation, the phone system must provide about 4000 Hz of audio bandwidth. This doesn't provide audiophile-quality sound, but it conveys all the frequencies a human being needs to understand speech. To convey each half of a call clearly, a single "channel" must carry 8000 bytes, or 64 Kbps. This amount of bandwidth—called a level 0 digital signal, or DS0—has become the fundamental unit of connectivity in the digital phone system.

As with analog carrier lines, it doesn't make sense for the system to devote a separate pair of wires to each connection from end to end. This is where the hierarchical architecture and time-division multiplexing come in: The data streams from 24 DS0 channels can be grouped together and carried by a DS1 (also known as T1) line. The signals from multiple T1 lines can then be multiplexed into digital trunks with still more bandwidth (i.e., DS2, DS3, and so on).

To allow multiple calls to share a trunk without interfering with one another, the Bell Labs scientists developed a time-division multiplexing scheme, called the T1 frame. Each frame of data on a T1, or DS1, line consists of 1 byte of data from each of 24 DS0 channels (each carrying a voice call or a data connection) plus a framing bit that indicates the beginning of the next frame (see the figure "T1 Frames Manage Time-Critical Data" below).

Multiplying 193 bits (24 bytes plus the framing bit) times 8000 frames per second gives you 1.544 Mbps—the clock rate of a T1 line. Note that this scheme is ideal for voice transmission because it's isochronous; that is, each channel is guaranteed a fixed number of regularly spaced "turns" during which its data is transmitted. (Ethernet, and other computer networking protocols, do not have this property; there's no guarantee that data will arrive on time to avoid an ugly gap in the audio signal.)



Of course, bandwidth is wasted if the party on the sending end is not saying anything or sending data. But nothing special needs to be done when all parties are talking at once. This makes the scheme simpler to manage than statistical multiplexing, which tries to make use of the extra bandwidth.

To sort out the data from an incoming T1 signal, the receiver must determine where each frame begins and ends. But since the frames are sent back-to-back in a continuous stream, and the data itself might not provide any clue about which bits belong to which channel, the sender needs to tell the receiver the location of the frame boundary. This is the framing bit's job.

The framing bit, which the sender transmits at the end of every T1 frame, varies from frame to frame according to a predetermined pattern. The receiver knows the expected pattern and scans the rush of incoming data to see which bit (out of every group of 193) is varying the right way. (It's always possible, of course, that another bit will also happen to fit the pattern, but the probability of this becomes minuscule over a large number of frames.)

Robbing Peter to Pay Paul

Designed to eke out every last bit of bandwidth from a digital trunk, the DS1, or T1, multiplexing scheme is also able to carry a small amount of additional data (e.g., billing and connection information) using a technique called bit robbing. In this technique, at every sixth frame the system "borrows" the least significant bit of one of the 24 bytes of data and uses it to carry internal switching information rather than data. The human ear isn't sensitive enough to miss such a small change in the audio signal.

But of course this isn't true of digital devices. Because that last bit isn't certain to come through reliably, the effective throughput of a data channel is cut from 64 Kbps to 56 Kbps. Thus, many digital leased lines have a bandwidth of only 56 Kbps. (Some equipment used for digital leased lines has been retrofitted to disable or hide bit robbing and to allow 64 Kbps of throughput on each channel—a facility called clear channel T1.)

Up the Hierarchy

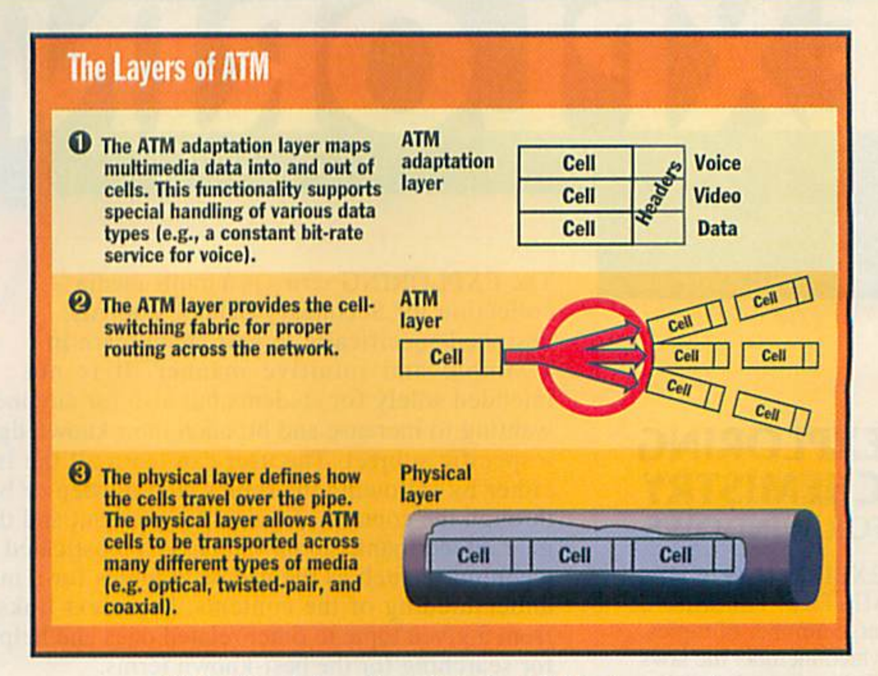
At first, a DS0 connection—already faster than today's fastest dial-up modems—seemed like more bandwidth than any user could reasonably want. Use of the upper levels of the digital hierarchy was confined entirely to the phone company's internal equipment. But after the famous Carterfone decision, in which the courts ruled that users could connect their own equipment to the phone company's lines, businesses became interested in renting larger digital pipelines and creating their own internal phone systems and WANs.

Divestiture, the breakup of the Bell System, and the entrance of competitors into the long-distance phone market have all speeded the move toward private voice and data networks. Equipment manufacturers, such as Stratacom (which was recently acquired by Cisco Systems), leaped into the breach, providing equipment that allowed a company to run its telephone systems, WANs, or both over the same rented T1 connection. **–Brett Glass** *is a writer, computer consultant, and teacher in Laramie, Wyoming. You can contact him at rogue@well.com.*

packets to deliver big chunks of data across a network. When X.25 was standardized in 1976, it was a watershed development, establishing a common packet-switching protocol for broadband networks. But in these heady days of multimedia convergence, X.25 transmission speeds just don't cut it.

On the other hand, frame relay requires little overhead because it leaves error recovery up to network-level protocol suites, such as TCP/IP and IPX/SPX. Frame relay can transport variable-size packets at up-to-T3 transmission speeds. However, frame relay was not designed to carry voice traffic. It discards frames in the event of congestion, it's not isochronous, and it can have long and sometimes unpredictable latencies (i.e., it can be a long time before data sent into a network emerges at the other end).

Equipment that tries to route voice traffic over frame-relay connections must play tricks in an attempt to ensure timely delivery of digitized voice packets. Also, because frame-relay bandwidth is far less expensive than dedicated leased T1 lines or ordinary voice-phone service, long-distance carriers aren't eager to support a technology that could cost them revenue. So, while it's possible to buy voice equipment for frame relay, it's best used only with relatively uncongested systems that can provide a committed information rate—that is, networks with a guaranteed minimum throughput.



ATM's fixed-length cells help ATM to transport voice and data efficiently.

The ATM Answer

Cell-relay technologies, such as ATM, outpace frame relay and also provide a more efficient switching mechanism. Instead of sending data in variable-size packets, cell relay uses small, fixed-length (53-byte) cells to transport information. Data packets are transmitted asynchronously, but the line of cells that carries the packets flows across the network synchronously as a continuous stream. The data packets enter the stream as they become available, dropping into the first available cell. These small packets support high-speed, low-latency transport.

Unlike synchronous transfer, which preallocates bandwidth channels, ATM transports data packets whenever bandwidth is required. ATM's flexible use of bandwidth supports the continuous uninterrupted transfer of voice and video data as well as data traffic's variable bit rates. It's also data-rate-independent, supporting public networks and LAN switching alike at rates exceeding a gigabyte per second.

ATM comprises three layers (see the figure "The Layers of ATM" above). You can run ATM to the desktop without bridging to another networking technology. Unfortunately, standards for voice and video transmission over ATM are still in the formative stage, and ATM equipment is relatively expensive.

The All-Digital Future

Enterprises integrating voice and data networks currently face an almost-bewildering array of choices. Many companies have bought into the obvious benefits of an integrated network, but high costs and immature standards are major deterrents.

Until prices drop and standards evolve for a variety of new digital technologies, the only sure bets are the tried-and-true voice/data technologies developed by the Bell System several decades ago—combined with new equipment designed to make the best use of them. ■

Stanford Diehl, a former director for BYTE reviews, currently works as a systems engineer for a large commercial printer. You can reach him at **sdiehl@bix.com.**

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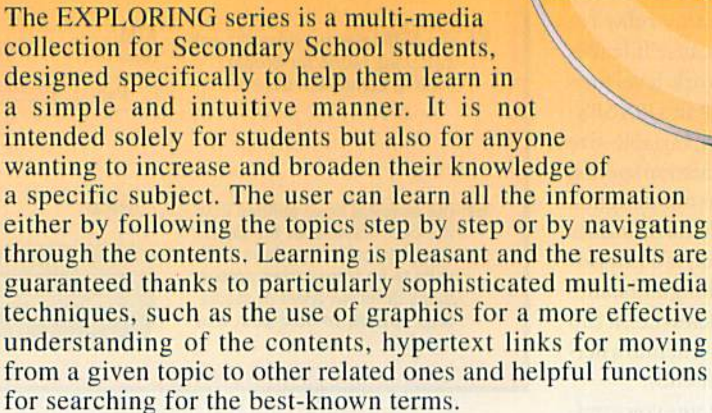
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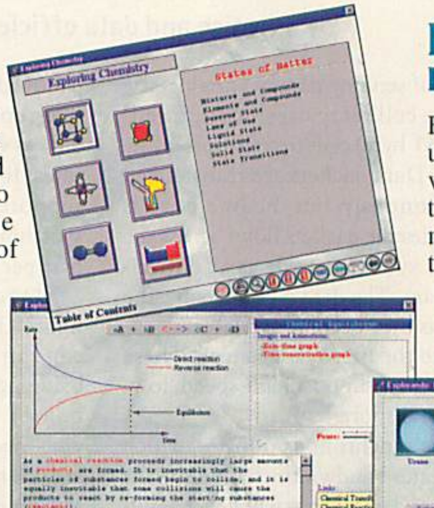
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Global Video Village

Three broadband platforms vie to make global video networks practical.

By Udo Flohr

Today's version of point-to-point video is more like pinhead-to-pinhead. You can connect to someone with 28.8-Kbps modems, and if you're both using a monitor-mounted digital camera and videoconferencing software, you can have postage-stamp-size images of your faces travel across the phone lines. Just don't move too often: There's only enough bandwidth to update your images every few seconds.

The demands of video transmission are higher than for any other data type. For video to work you need high bandwidth, fast connections, and the ability to send and receive the images at equivalent rates. The leap from small, jerky images to full-motion video that you can send to anyone, anywhere, over a ubiquitous digital network will be the confirmation that convergence has arrived.

What's the payoff for being able to send video as easily as a page of text? For one thing, videoconferencing ceases to be nine parts setup and one part collaboration. And tele-presence becomes real, so you can call an expert on another continent to help you overcome a technical problem on a complex piece of machinery or aid in a difficult medical procedure. Sales presentations and training sessions can take place without anyone having to hop a plane.

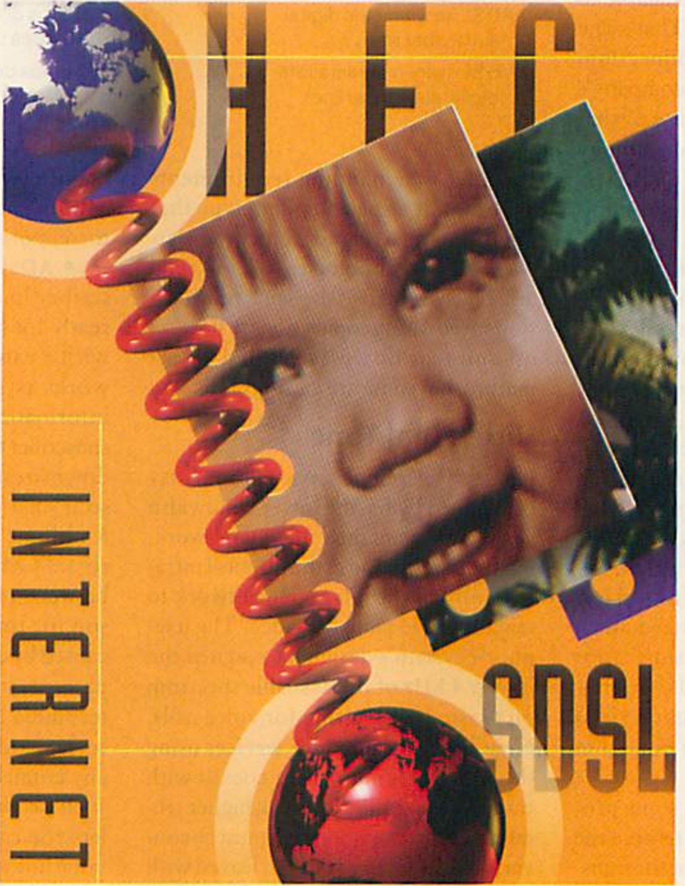


ILLUSTRATION: ROY WIEMANN © 1996

But don't cancel your airline tickets just yet. The requisite high-bandwidth pipes aren't fully in place, and technologies for transmitting video globally aren't fully formed. The existing telephone system handles point-to-point connections and can establish these connections quickly. But bandwidth limits mean that companies have had to maintain separate data and video networks. The main alternative is the cable TV (CATV) network, which can deftly handle video streams but was built to broadcast video in a one-to-many model; point-to-point, temporary, and symmetrical (i.e., equivalent sending and receiving transmission speeds) connections are stumbling blocks for CATV. These aren't the only possibilities. Some analysts see wireless technology as a powerful candidate. Unfortunately, all these approaches have weaknesses that keep them from offering a total solution for creating an anywhere-to-anywhere video network.

The high demands of video mean the final solution will touch on all the different layers of the communications infrastructure. This includes the actual, physical medium that carries video (i.e., copper phone wire, coaxial cable, optical fiber, or wireless mechanisms) and the transport standards, like asynchronous transfer mode (ATM), that manage the flow of data. The final component will be the actual applications that implement such things as telepresence, videoconferencing, or Internet-based virtual reality.

Great Expectations

For MPEG-1 video quality, a network needs to handle about 120 to 140 Kbps. That translates into the equivalent picture quality of a VHS tape (352 by 288 pixels, at 8 bits per color and 30 frames per second). MPEG-2 quality, which would be necessary for a telepresence application that ships detailed technical information in real time, requires about 500 Kbps, which translates into the sharpness of S-VHS.

For video to truly become a ubiquitous data type, tomorrow's networks will need to transmit video in both directions at the same speed (i.e., full duplex). For this you'd need 4 to 6

Mbps. (You would also need real-time encoding to compress raw video data on-the-fly.) Video data also has to arrive in a continuous stream and in real time: It is unacceptable for any individual frame to be delayed or for any associated audio track to arrive out of sync with the picture. The result would look like a poorly dubbed foreign movie.

Shared connections are often unsuitable for real-time video applications. If network traffic is low, your video communication will have enough bandwidth as long as you're using one of the evolving broadband technologies like cable modems. But if the cable alternative becomes a popular way for people to set up video connections, the increased demand could mean many people are vying for the same pipe, and there is no guarantee that the portion available to every user will be adequate. That's one advantage of a dedicated connection, like a T1 link, to connect your company's offices: You have exclusive use of that connection. However, you also pay thousands of dollars a month for the service, and your communications abilities are anything but global. A leased line doesn't connect you to the outside world, including that potential customer who might be sold on the flashy sales presentation your corporate communications department recently created.

To make matters worse, an MPEG data stream is by no means constant. It varies greatly, depending on the type of video you're encoding. The compression ratio improves when images in consecutive frames don't change much. Sequences with lots of motion afford less compression and therefore need much more bandwidth. Compression ratios may vary between 1:50 and 1:200 within the same video file. As a result, a video network should guarantee a minimum throughput level.

To resolve this situation, some protocols, namely ATM, let you reserve the right amount of bandwidth for the transmission by assigning a particular "quality of service" level when you first make the connection. (For more on ATM's service levels, see "Virtually Well Connected," August BYTE.)

How well does the Internet fare in meeting these demands? Today, the Net isn't reliable enough to deliver real-time video. Too often, bandwidth on the Net is like a magic act: Now you see it, now you don't. The variations depend on the time of day you're logging on as well as the topology between the points you want to connect. Add to that the reality that the Internet isn't a commercial entity, so there's no central authority that can guarantee you get the resources you need. This situation may change when the Net's data paths become wide enough to absorb video (see this month's cover story, "Breaking the Bandwidth Barrier," on page 68).

The High Speeds of Digital Subscriber Lines

Name	Data Rate
HDSL (high-data-rate digital subscriber line)	1.544 Mbps (requires two twisted-pair lines) 2.048 Mbps (requires three twisted-pair lines)
SDSL (single-line digital subscriber line)	1.544 Mpbs (one line) 2.048 Mbps (one line)
ADSL (asymmetric digital subscriber line)	1.5 to 9 Mbps downstream 16 to 640 Kbps upstream
VDSL (very-high-data-rate digital subscriber line)	13 to 52 Mbps downstream 1.5 to 2.3 Mbps upstream

Video's demanding requirements have kept it a specialty data type that needs expensive and dedicated networks. The technologies to let us send and receive video at the same transmission speeds using connections that we set up and tear down as needed aren't mature, but some are getting close.

Video Dial Tone

Plain old telephone service (POTS) may be plagued by having lower bandwidth capabilities than the cable TV network, but there's nothing in the physical infrastructure of the telephone network to make it inadequate for video. The telephone system's designers assigned the lowest 4 KHz of the available spectrum on twisted-pair wiring for voice calls. New, higher-bandwidth services using the same wires must either coexist with traditional services by using higher frequencies, or telephone calls must be converted to digital and be interleaved with other data. Much of the current phone system is already digital; the final connections to end users are the remaining analog holdouts.

In the early 1960s, engineers at Bell Labs designed multiplexing systems that digitized voice into 64-Kbps data lines and then sent several of them in a framed stream. This first structured signal was called DS1, which spawned T1 and E1 lines (at 1.54 or 2.04 Kbps, respectively). However, these lines need repeaters every 6000 feet and require 1.5 MHz of bandwidth, which is high by today's standards. Interference is another disadvantage: Only one T1 line can operate problem-free in a 50-pair cable. This is why a variety of digital subscriber line (DSL) technologies may be the long-term answer.

DSL can turn a standard pair of copper wires into a sophisticated digital highway when you add digital modems at both ends. DSL variations come in a torrent of acronyms:

- ADSL (asymmetric digital subscriber line) is the first DSL variation ready for high-quality video data, but with a catch. As the name implies, it works asymmetrically, so much more information can be transmitted to the subscriber than what comes back. ADSL's downstream rate is affected by distance, so at 9000 feet, ADSL achieves a speed of 8.4 Mbps; at 18,000 feet, the rate drops to 1.54 Mbps. The upstream rate is between 16 and 640 Kbps. The main reason for this limitation is interference caused by capacitive couplers within the phone system. This means ADSL is better suited to distribution-type services, such as video on demand, than any-to-any connections. (It is also suitable for Web browsing.) Furthermore, ADSL lets you carry on conversations on the same line where video is streaming, and your phone service works even if the ADSL modem fails.
- HDSL (high-data-rate digital subscriber line), using more advanced modulation, is less demanding on spectrum and needs no repeaters. It also delivers 1.54 to 2.04 Mbps. HDSL can go up to 12,000 feet, but it requires two twisted-pair lines for T1 or three for E1.
- SDSL (single-line digital subscriber

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line) delivers the same speed as HDSL over a single line, at up to 10,000 feet.

• VDSL (very-high-data-rate digital subscriber line) is, for the time being, also asymmetric, but at even higher data rates. Downstream, it offers speeds between 12.9 Mbps at 4500 feet and 51.8 Mbps at 1000 feet. Upstream rates are from 1.6 to 2.3 Mbps. VDSL is intended for ATM networks. Both ADSL and VDSL provide error correction.

DSL is taking the world a step closer to high-end, point-to-point video, and the bandwidths it offers are enticing. But as long as the technologies are asymmetric, DSL is not a complete solution for transforming the existing phone infrastructure into a powerful, multimedia data highway.

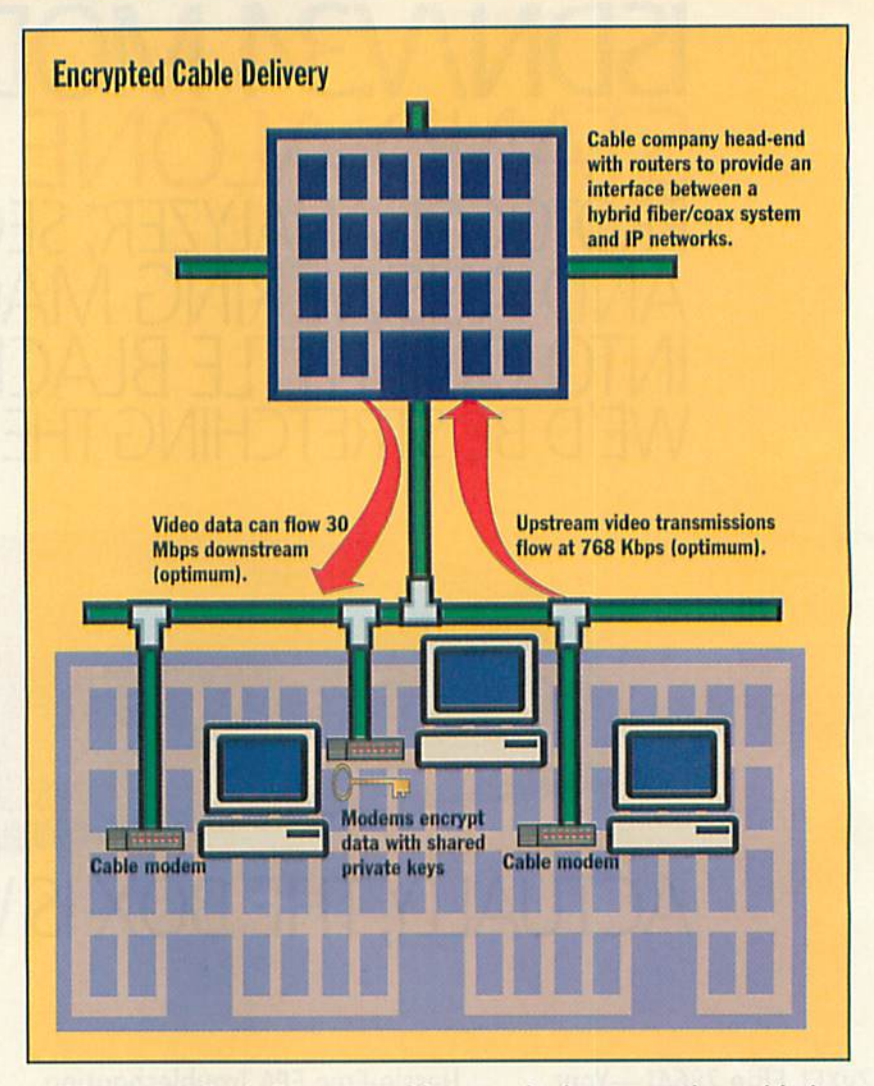
Cable Guy to the Rescue

Just as DSL provides new capabilities for standard POTS networks, the CATV network is being enhanced to deliver fast data-access services. Cable modems are currently being used in trials throughout the United States and Europe. These projects aim to find a way to make the high-capacity cable network suitable for point-to-point connections. Video data still goes to all the cable subscribers connected to the loop, but the modem filters out the information addressed to a particular subscriber. This establishes a virtual point-to-point connection, at least in one direction.

But much of the existing cable plant still can't accommodate two-way traffic. To overcome this limitation, cable companies need to upgrade their infrastructure by adding routers. This refurbishing project could cost an estimated $500 per subscriber, not including the price of the cable modem, which could double that amount.

But the promise of broadband speeds over an existing network can make some people gloss over the costs. The theoretical limits of cable connection speeds may be as high as 30 Mbps. But realities quickly bring this theoretical rate to more modest levels, perhaps to speeds that are two-thirds slower, or roughly equivalent to what ADSL modems offer. Performance penalties are due in part to the fact that cable subscribers share available bandwidth, much like clients on a LAN.

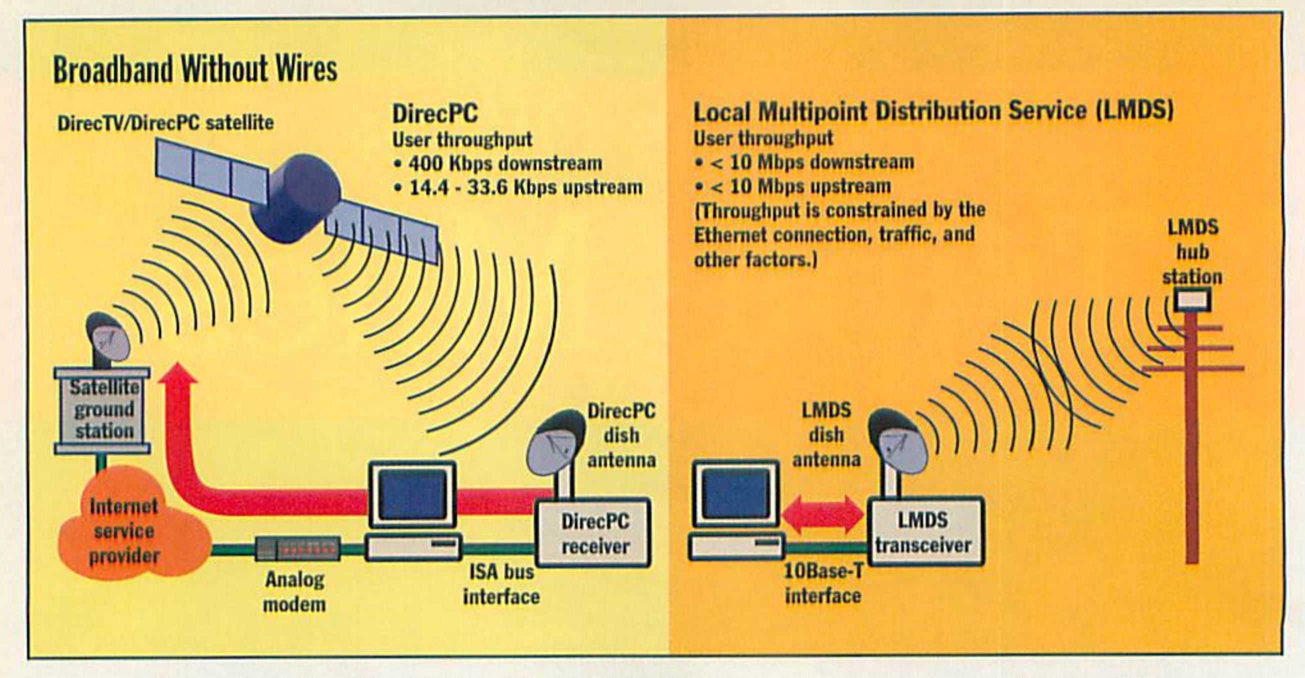
One glimpse into how cable companies might offer CATV networks as a video link to corporate customers is Motorola's CableComm, a turnkey solution for implementing video CATV services. The package includes modems and subscriber access software. The necessary cable router that installs at the head-end interfaces with a hybrid fiber-coax (HFC) distribution network to local or remote IP networks. In the CableComm solution, a channel occupies a 6-MHz slice of downstream bandwidth, in the range of 65 to 750 MHz. The cable router manages all the modems in the system and prompts them to shift to alternate channels. Each downstream channel provides a 30-Mbps raw data rate, with 768 Kbps upstream. Since all traffic passes all the premises that are connected to the network segment, the system encrypts messages with shared private keys unique to each modem.



Motorola's CableComm provides security by encrypting cabled messages with private keys unique to each modem.

Fiber-optic lines combined with CATV's coaxial networks may play an important role in the development of anywhere-to-anywhere video networks. A single fiber can transmit up to 30 terabits per second, or the equivalent of 450 million simultaneous phone conversations with digital quality. HFC is a combination of fiber-optic trunk lines, which bring the data over long distances, and coaxial cable networks, which provide the local-loop links.

On paper, the combination of high bandwidth with an existing infrastructure makes HFC an ideal candidate for video applications. The main drawback of this approach, however, is implementation expense. Large-scale HFC deployment requires new cabling or at least refurbishing existing coaxial cables. In cities, that means a lot of digging; in



Two ways to broadcast: DirecPC zaps data from a geosynchronous satellite to a dish attached to your PC; LMDS uses ground-based transceivers and avoids analog modems.

less populated areas, amortization seems impossible. Estimates on cost per subscriber start at $700.

Wireless Wonders

One way to get around the technical problems inherent in today's telephone and cable TV networks is to bypass those infrastructures altogether and go wireless. Advantages of wireless solutions, like satellite networks, include flexible and high-speed bandwidths, high reliability, and the ability to reach any location with near-zero setup time.

Some Europeans are already familiar with the advantages of satellite communications. For example, the Astra family of direct broadcast satellites now delivers hundreds of TV and radio channels to about 10 million customers. But wireless broadband networks have trade-offs of their own. Two examples illustrate this point. The first is DirecPC, by Hughes Network Systems. DirecPC transmits data from a geosynchronous communications satellite directly to a dish antenna that you attach to your PC. Direct satellite broadcasting minimizes industry investment in new ground-based infrastructure, largely because users buy most of the equipment themselves. The antenna, receiver, ISA interface card, and software cost about $1000. Professional installation costs about $500 more unless you install the equipment and align the dish yourself—a nontrivial task.

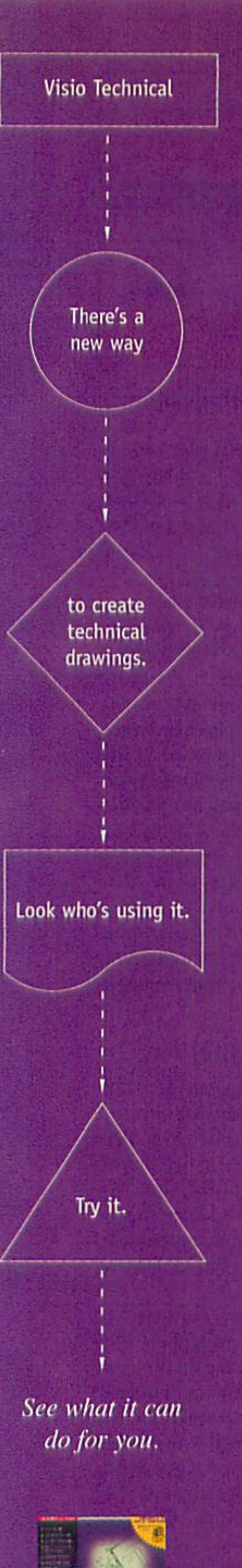
Service charges for Internet access via DirecPC depend on usage, which is measured in megabytes, not minutes. You pay 80 cents per MB during peak hours and 60 cents during off-peak times. You can buy monthly packages that range from $15.95 for 30 MB a month to $39.95 for 130 MB a month. You also need a separate dial-up account with an Internet service provider (about $20 to $30 a month).

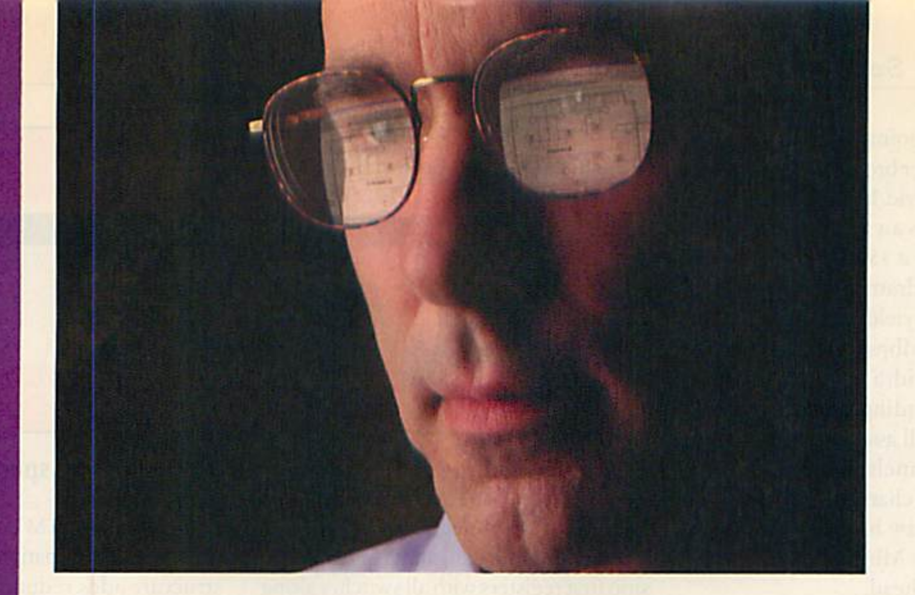
Why a dial-up account? Although DirecPC can broadcast data downstream to your compact dish antenna, you can't transmit data upstream to the satellite without turning your PC into a NASA tracking station. Instead, the return path is an ordinary analog modem that dials up your local Internet provider over a standard SLIP/PPP connection. The result is a highly asymmetric network: 400 Kbps downstream and 28.8 Kbps (or whatever the speed of your modem is) upstream. The downstream path is about 14 times faster than a 28.8-Kbps modem but well short of the megabit-per-second speeds that cable modems and ADSL potentially deliver.

Actually, DirecPC has enough bandwidth for a maximum rate of 11.79 Mbps downstream. However, that bandwidth is shared by all users on a single satellite transponder. Hughes says it will add more transponders if there's enough demand. Still, the lack of a broadband return path will limit DirecPC to applications that tend to be asymmetric, such as Web browsing and software distribution. This isn't the solution for Web publishing, videoconferencing, or fast-lane telecommuting.

Another broadband wireless alternative is local multipoint distribution service (LMDS), a two-way digital broadcasting system that eschews satellites in favor of ground-based transceivers. LMDS needs a portion of RF spectrum, which the U.S. government plans to auction off this fall. Spectrum buyers will then have to build a new infrastructure to launch LMDS.

LMDS will use a 1-GHz-wide chunk of spectrum that starts at the extremely high frequency of 28 GHz (27 GHz in Canada). Due to this very high frequency, the user's dish antenna can be even smaller than DirecPC's (probably 9 to 12 inches in diameter). The antenna points at a neighborhood hub station that's mounted on a high roof or pole. The hub station houses a transponder that communicates with the network's central office. The central office is analogous to a cable TV system's head-end; it handles all routing and switching and also bridges to the Internet. Although LMDS is not a fully switched network, it can







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Like most other broadband solutions, LMDS is asymmetric. It divides the 1 GHz of airspace into an 850-MHz downstream path and a 150-MHz upstream path. QPSK (Quadrature phase shift keying) modulation yields 1.3 Gbps downstream and 240 Mbps upstream. That's aggregate bandwidth shared by all users on a hub. Depending on the network design, LMDS will assign multiple users to separate channels that are 20 or 40 MHz wide. Each channel can deliver 32 or 64 Mbps of raw bandwidth, which drops to 25 or 50 Mbps after error correction and overhead.

Users need a special LMDS modem that attaches to an Ethernet port, which limits the maximum bandwidth to 10 Mbps. As with cable modems, actual throughput depends on the amount of traffic on the same channel and the computer's I/O efficiency.

Proponents hope to deploy large-scale LMDS networks for about $1000 per user. That includes the cost of the modems and hub stations but not the RF spectrum. Assuming that LMDS networks come close to that price target, users might pay about the same access fees as they would for cable modems. But LMDS companies may be able to build their networks faster than cablecos can upgrade their infrastructures for broadband service.

Eventually, one broadband technology, whether it's wired or wireless, will probably emerge as the dominant solution. But it'll be many years before any broadband network achieves universal coverage. In the meantime, there'll be room for alternative solutions that can reach users who aren't covered by other networks.

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Package Deals

The pipes—or airwaves—we dedicate to moving video from point to point are just one piece of the video-network puzzle. The protocols and standards that package and transport video files are equally important and, in some cases, similarly a work in progress.

ATM integrates video, data, and voice. ATM packages cells at fixed lengths to achieve fast switching. Cell size is 53 bytes, including a 5-byte header containing code for error control, address information, and priority control. The other 48 bytes carry the payload. ATM is connection-oriented, so, like a telephone call, an ATM transmission first registers with all switches along the way. Each cell is then guided to the next node by each switch. The data stream itself need not be concerned with routing, a degree of transparency that makes ATM flexible. Thus, computers, TVs, phones, and fax machines may eventually all be equipped with ATM switches. The costs of an ATM connection will depend on the amount of data that's being transferred, independent of the distance.

ATM speeds are scalable from 25 Mbps to more than 1 Gbps. In addition, ATM switches can transparently buffer and thus adapt data rates between slow and fast devices. Because ATM can guarantee a minimum bandwidth for a connection, it is ideally suited for point-to-point video.

The main drawback to ATM so far is its slow rollout. But that is changing: Finland and Germany are among the first countries that have commercially available switched ATM networks in place. (For more information about ATM's evolution, see "Is ATM Ready to Catch Fire?," August BYTE.)

In the meantime, other protocols exist for video applications. Distributed Queue Dual Bus (DQDB) works at speeds of 34 and 140 Mbps, duplex mode. DQDB uses two separate directional buses to which all nodes are attached. The bus's head-end generates empty cells that pass other nodes and acquire information payload. This payload data then travels onto the recipient node, as if it's in a container.

DQDB is connectionless: Each cell contains the necessary routing information, and end points communicate with each other at different speeds. A cell's size is 53 bytes, 5 of which are address information. This is the same size and format as ATM cells, which makes the schemes compatible. The double-bus structure adds redundancy, which adds to DQDB's reliability: Even if one bus line fails completely, the system can reconfigure itself in a matter of seconds.

Broadband ISDN (BISDN) is a set of services that define how to transport video and other types of data at speeds starting at about 150 Mbps. The transport backbone for BISDN will be an optical time-division-multiplexed network. In the U.S., BISDN will be based on synchronous optical network (SONET) technology; in Europe, on synchronous digital hierarchy (SDH) technology. Because it's fiber-based, BISDN provides higher data rates and lower error rates than the current DSL-based ISDN. It offers both synchronous and asynchronous transfers. ATM will be the underlying transport technology within the BISDN protocol stacks.

Wait for the Sequel

What will be the components of tomorrow's switched video network? In a perfect world, we'll send video over high-bandwidth fiber using ATM to transport real-time images smoothly and efficiently. But to reach that happy ending, we have to wade through a messy world of copper wiring, coaxial cables, and incomplete solutions.

Meanwhile, pioneering switched video networks will convert phone lines into video corridors or tap the potential of CATV. Wherever the two are not available and fiber is too expensive, satellite solutions, complemented with wireless systems, may shed their science-fiction image and become more commonplace data transport mechanisms. ■

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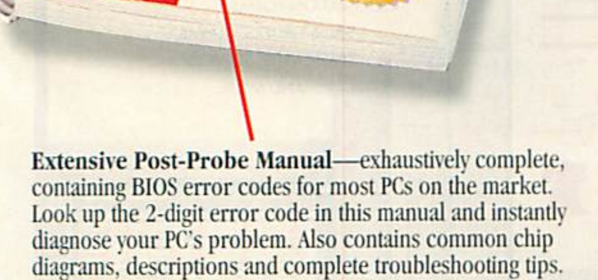
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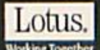




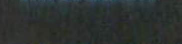
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Forms Follow Function

The Web is changing the way companies automate forms processing.

By Peter Jerram

Paper forms are a necessary evil of modern life. Each year, businesses and governments spend billions of dollars to design, print, mail, process, and file those prosaic stacks of paper.

Electronic forms (e-forms) have been touted as the conquerors of paper glut, with promises of streamlining the tasks of form design, data entry, and routing. By identifying routing bottlenecks and providing better tracking, e-forms also might help organizations cut costs. "It's hard to reengineer your business processes if you don't know what they cost in the first place," says Wayne Gramlich, Sun Microsystems' representative on the World Wide Web Consortium. "On-line forms provide a very direct way to pinpoint expenditures."

With business process reengineering in vogue among management theorists these days, you might expect to find a huge e-forms market. Think again. Steven B. Weissman, an analyst at Kinetic Information (Waltham, MA), estimates the 1996 worldwide e-forms business at about $92 million, which is a relatively tiny niche.

So how can e-forms become more widespread? One answer, according to forms-software vendors and potential customers, is—surprise!—the Web. As more companies set up public Web sites and private intranets, it makes greater sense to integrate forms with Web pages and link them to existing back-end processes. The potential Web benefits are all in the front-end of the document-flow process. Customers and clients can use any standard Web browser to quickly locate the forms they need on the company's public Web site, while employees can get the forms they need on their company's private intranet. And it's all based on a standard Web-like architecture supported by a growing number of tools and products.

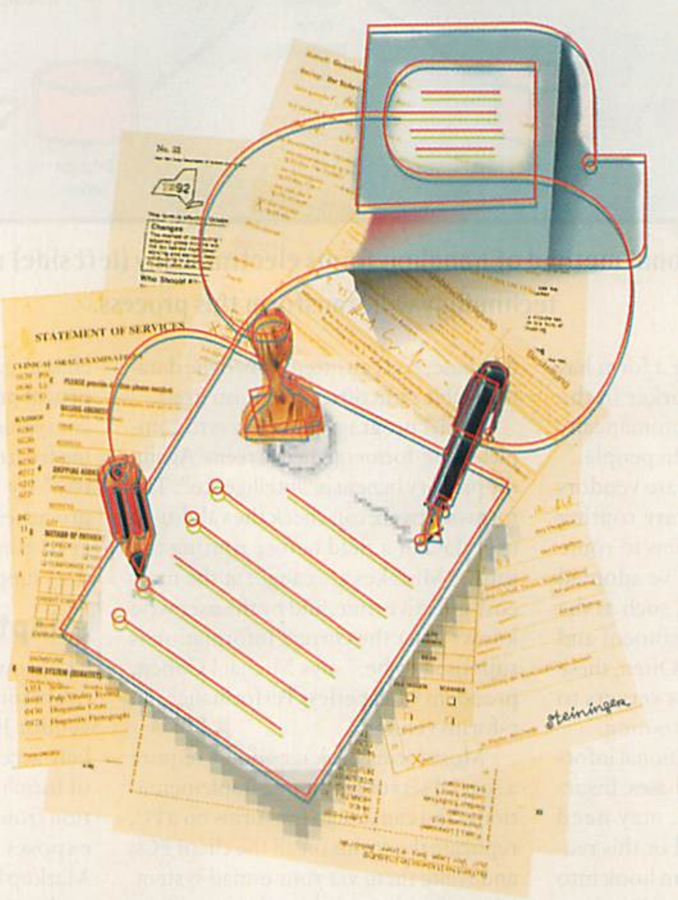


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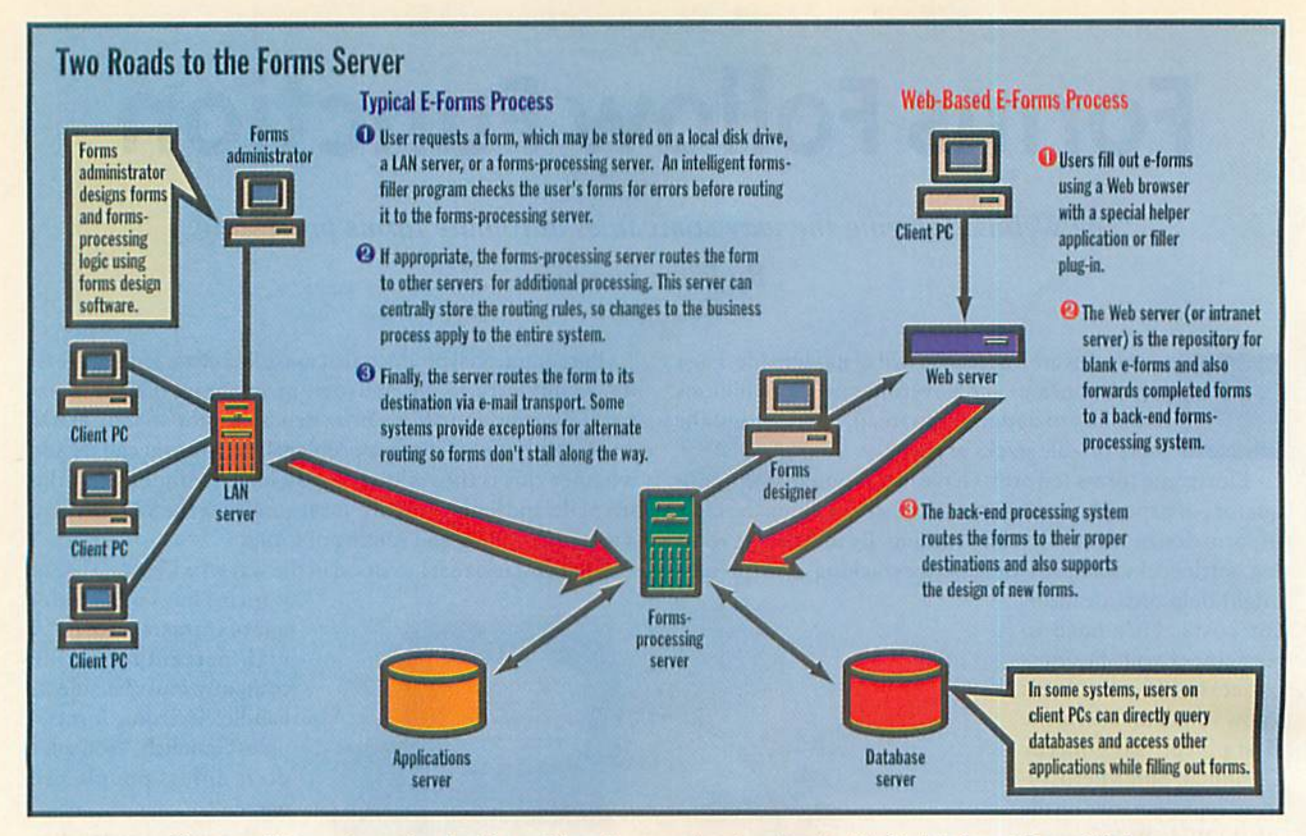
But commercial products that make Web-based forms a reality are only just arriving, and some people argue that the Internet is a communications infrastructure, not an automatic answer to business process problems. Before you can decide whether this is the right step, you have to understand the strengths and limitations of e-forms, and how the Web can play a role in the filling and routing of forms.

One obstacle that has stood in the way of wide-scale use of e-forms has been inadequate infrastructure. "A high percentage of the company must be able to handle electronic forms," notes Gramlich. "You can't do it unless people are wired."

Forms software has progressed slowly as well. "Until about two years ago, electronic forms really just supported basic fill and print capabilities," admits Eric Stevens, group product manager at Symantec, the leader in this market.

As progress happens on both fronts, the basic concepts behind e-forms remain constant. Typically, forms software comprises two basic modules: a client program, called the filler, and a design program that someone uses to create and administer the forms (see the figure on the next page). The design program is a visual layout tool that lets you mimic the look of a paper form by arranging text, graphics, tables, check boxes, and other elements. Most forms designers also supply a number of templates you can use or modify for specific purposes. But the true benefit of e-forms isn't their ability to mimic a paper form on a computer screen. It's the native intelligence of the back-end process.

By specifying a set of routing rules, for example, you can create a smart form that automatically dispatches to the appropriate individuals in the approval loop. Forms software varies in the way it handles this kind of routing. Some products require



The traditional method of handling forms electronically (left side) and how Web technology will transform this process.

that each person approving a form has to e-mail it to the next worker in the loop. Other products can automatically route the form to all the right people.

In the past, forms-software vendors tended to use the proprietary routing mechanisms of e-mail systems to route forms. More recently, they've adopted emerging e-mail standards, such as the Internet Message Access Protocol and Microsoft's Messaging API. Often, these systems also use work-flow servers to handle administration and routing.

Many forms require additional information from back-end databases. Insurance forms, for example, may need data from actuarial tables. For this reason, most forms software can hook into databases, often through Open Database Connectivity (ODBC) drivers. For cleaner links and better performance, some products natively support major databases, such as Oracle7, SQL Server, and Sybase. A forms package that lets you specify these links by editing a database table structure from within the forms designer is much easier to use than a package that requires naked SQL queries. If you don't have direct access to a linked database, you can often embed the database table structure in the form itself.

A filler program allows users to complete the e-forms on their screens. Again, the primary benefit is "intelligence": The forms software can check the validity of user data in a field before routing the form. "Mistakes are caught at the most cost-effective time, and by the user who knows what the correct information is supposed to be," says Michael Cohen, president of Paperless Performance, an e-forms vendor.

Most forms packages don't require a special server for simple implementations. You can design the forms on a PC, replicate the forms on all the client PCs, and route them via your e-mail system. More sophisticated implementations require a server that stores the forms, manages the work flow according to predefined rules, and handles communications with other back-end applications (such as database servers).

Maintaining the work-flow rules on a central server is particularly important. This enables businesses to adapt e-forms to rapid changes in business processes. "Business processes change, and they change fast," explains Gramlich. "Approval processes change all the time as companies implement cost controls, hiring freezes, and capital expenditure limits." By housing the rules for these processes at a central location, it's easier to adjust the behavior of the forms they support.

Adapting the Web

The growing popularity of the Web may rub off on e-forms. According to e-forms vendor JetForm, about half of all publicly accessible Web sites use some kind of form to collect and process information from users. However, the Web also exposes the limitations of Hypertext Markup Language (HTML) for the more sophisticated demands of e-forms. "With HTML, we're still stretching to do anything with entry validation or database lookup in real time prior to forms submission," says John Hendricks of Workflow Solutions, a value-added reseller in Bellevue, Washington.

HTML forms will get better, but not soon enough for many organizations that could take advantage of this technology today. "We understand that current Web

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forms are kind of wimpy," says Web Consortium member Gramlich, "but it's not the highest priority right now. I'm guessing that we won't see the first phase of a forms upgrade until mid-1997."

Electronic commerce is a natural application for on-line forms, but the spectacular rise of private intranets based on Web standards is creating even more opportunities for deploying e-forms within organizations. The relative simplicity of an intranet makes it easier for in-house developers to create applications for work-flow automation and database access, which are central to a workable forms process.

"The Web is acting as a focal point, but this is a new twist on an old theme, not a completely new way of doing business," according to Hal Bennett, an Internet commerce consultant based in Menlo Park, California. "Computers have been 'electronifying' forms since day one. Most client/server systems, for example, have long enabled forms-based business processes."

But client/server solutions can be expensive to implement and are sometimes more complicated than the mainframe solutions they were intended to replace. One possible alternative: a more economical intranet that uses Sun's Java language to drive intelligent forms. A compact forms filler written in Java can run on almost any client operating system and download with the form to the client workstation.

That would be a boon for large organizations that must cope with huge distribution and maintenance problems each time they change a business process or upgrade an application. "Far and away the biggest issue for customers is the ability to deploy enterprise-wide work-flow-enabling applications without having to go to the client," says Hendricks. "At Boeing, for example, we're talking about over 30,000 desktops."

In effect, the intranet/Java model could combine two different approaches: Melding the advantages of mainframe computing, which centralizes maintenance and deployment, with client/server computing, which off-loads some of the data processing to lower-cost client workstations.

Vendors Board the Bus

E-forms vendors are taking different approaches to this new technology.



JetForm's filler plug-in for Netscape Navigator.

Some see the Web as a widely accessible and up-to-date warehouse for e-forms. "We're using the Web as a distribution and transaction system," says Cohen of Paperless Performance. "A user could go to the Small Business Administration site, for example, and download the forms for an electronic loan application using our NeoForms helper app."

Web servers are potentially superior to LAN servers for storing forms because the Web centralizes access. "Putting forms on a Web site simplifies updates, and with a single place to go, people don't get lost as easily," says Joanne Correia, JetForm's director of Internet and small business products.

JetForm is among the most aggressive forms vendors in the development of a Web strategy. In July, the firm released JetForm Web Filler, a plug-in for Netscape Navigator. It lets users view and fill out non-HTML e-forms with a familiar Web browser interface. First, users have to download the version of Filler that's specific to their platform, because this version isn't written in Java. Currently, versions are available for Windows 3.1 and Windows 95. When the user clicks on a Web hyperlink that leads to a matching e-form, Navigator launches the filler application and downloads the form.

The first time a user requests a particular form, the Web server sends the latest version. If the user requests the same form later, the server checks to see if the user has the most recent version. If not, the server automatically sends the updated form. One disadvantage of this arrangement, however, is that users don't know if there's a new form without hitting the server. "The Web environment is not client/server—it's a terminal emulation environment," says Correia. "That's why everyone's looking to Java."

As the user enters data into the form, JetForm Filler validates the information and also provides drop-down menus of acceptable entries for given fields. A purchase requisition, for example, might list only company-approved items in the menu (see the screen shot above).

When the form is complete, the user clicks a Submit button to send a data file back to the Web server. JetForm's back-end forms-processing server polls the Web server at intervals and picks up the data files. At that point, the JetForm server can pass the data to another application, add it to a database, or send it to a work-flow server. Eventually, the form will probably be routed to the appropriate individuals through an e-mail system. "This approach leverages the Web to gather data but uses an organization's existing e-mail and LAN system to route the form," says Correia.

In other cases, people might simply use the Web to download a form, then route it to the appropriate person themselves as an e-mail attachment. This works particularly well for the growing corps of mobile users who may have trouble logging onto the corporate LAN remotely but can easily gain access to the Web. "If you don't have a story that works for nomads, you don't have a story," says Gramlich of Sun and the World Wide Web Consortium.

The Future of E-Forms

Forms on the Web could really catch fire when more Java applications begin to appear. JetForm has a prototype Java

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Flying in Good Form

When aircraft of the Federal Aviation Administration's Office of Aviation System Standards (AVN) take wing, their crews carry an unusual payload: about 650 pounds of computerized measurement equipment. AVN certifies ground navigation systems nationwide, ensuring their accuracy within fine tolerances. "We analyze to the microamp what the signal strength is when it radiates into space," says Scott Rose, computer specialist and project leader in AVN's Oklahoma City headquarters. "If you're flying into an airport in bad weather, you want the navigation system to be accurate."

AVN is responsible for testing all the components of landing systems: the instruments that provide electronic guidance, radar, and even the runway lights—"anything that brings an airplane closer in to an airport," says Rose.

The U.S. government requires that the AVN crews write up their analyses and test results in detailed reports. For the past several years, AVN has been using Symantec's PerForm and FormFlow software to fill in and route these reports. "We originally just did fill and print," says Rose. "Now we route via electronic mail, so field reports can be viewed back at the home office."

Rose is looking forward to a Web-based e-forms solution. It might better support a plan to create a pool of crew members who aren't based at a specific location. "A Web-based form filler would give us better access and mobility," he says.

Until that happens, the current system is linked to an Oracle database containing data on aircraft movement operations, crew personnel records, and operational costs. "We dump our Oracle data into a query table and read it with FormFlow," says Rose. "That way, if a form changes, we change a query, not the whole system."

The forms software also protects the integrity of the data, which is vital because the reports must be able to stand as legal documents. "FormFlow gives you a locked file, and you can use an electronic signature to bind the data to the form," explains Rose. (However, AVN does not currently use this feature because the government requires genuine handwritten signatures on each report.)

The FAA uses Symantec's FormFlow.

AVN is planning to revamp its procedures by collecting the data in-flight, downloading it to the ground, routing it to the proper destination, and then filing the reports electronically—a completely paperless process. This year, AVN aircraft began testing the first phase of that plan, in which airborne crew members enter the information into e-forms software running on laptops. By the end of next year, says Rose, the aircraft's own measurement computers will be able to fill in e-forms directly.

filler that has many advantages over the current version. First, it's more compact and downloads more quickly with the requested form. Since Java code is platform-independent, vendors won't have to support multiple executables, and users needn't concern themselves with downloading the proper filler program for their machine. Just-in-time compilation is an option if the interpreted Java applets aren't fast enough.

By removing some of the technical obstacles to client-side deployment, the Web and Java technology may reduce the cost of implementing e-forms solutions. "The forms automation companies have tenaciously held to the seat licensing model, and large companies are pretty tired of paying the price," says reseller Hendricks of Workflow Solutions.

As a result, some forms-software vendors, including JetForm, are planning to make their Java-enabled fillers available at little or no cost. If electronic commerce on the Web takes off, forms vendors will have an even better reason to streamline their client components: Every order-entry screen will need some kind of e-form.

Sun is exploring the possibilities of a Java-based forms solution. Gramlich, however, suspects that the window of opportunity for these solutions might be limited. "After the phase we're entering now—with Java-enabled and, if Microsoft gets its way, ActiveX-based forms—I think we're going to see a shift back to HTML for perhaps 80 percent of electronic forms," he says. "They're easier to develop, and you'll be able to get everyone to agree to a forms standard built on HTML."

Perhaps that's why many companies are taking a wait-and-see approach to this new technology. The Bank of Boston, which has 3000 users completing expense forms electronically with JetForm software, is on the fence. "There's a fair degree of interest," says Bob Nowak, the bank's director of workgroup technology, "but the Internet is still an unknown today. People are treading carefully before they really go out and do something with it."

Others see the Web not as a solution but as simply the latest transport mechanism. "It's an infrastructure, and infrastructure doesn't solve business problems," says Symantec's Stevens. "Applications using infrastructure solve business problems."

The salient contribution of the Web may be its influence on the convergence of work-flow automation, client/server computing, and e-forms. Whether the forms are implemented with HTML, Java, or proprietary plug-ins, the common denominators would be HTTP on the servers and Web browsers on the clients. The Internet/intranet architecture may prove to be the catalyst that brings it all together. ■

WHERE TO FIND

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Comparison

With Intel's latest 200-MHz CPU, cost-effective quad-Pentium Pro servers reach new performance levels. By Dave Rowell and Peter D. Varhol

Powerhouse Pentium Pro Servers

When Intel designed the Pentium Pro processor, it had more than just the desktop market in mind. With internal parity-checked registers, ECC-protected (error-correction code) caches, built-in diagnostics, and the ability to maintain L2 cache coherency with up to four processors, the Pentium Pro should make one heck of a server. Coupling the Pentium Pro with its 82450GX PCI chip set, Intel provided high-end PC vendors with a compelling server architecture that adapts to the needs of customers entering the midrange server market.

It's taken almost a year to get the bugs out of Intel's complex chip set (or work around them), but the first quad-Pentium Pro servers are proving both capable and cost-effective. We got our hands on two of the first systems to use Intel's latest 512-KB-cache version of the 200-MHz Pentium Pro and find that they make impressive application servers. We looked at preproduction versions of ALR's Revolution Quad6 and Compaq's ProLiant 5000 in July, both equipped with four 200-MHz/512-KB Pentium Pros. Similar systems should now be available from Dell, Digital Equipment, Hewlett-Packard, IBM, Intergraph, and IPC.

ALR REVOLUTION QUAD6

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★
PERFORMANCE	★★★★★

Clearly, the Intel architecture coupled with industry-standard peripherals can offer much lower costs than an architecture and peripherals designed for one of the lower-volume RISC processors. The systems evaluated here have starting prices between $30,000 and $35,000 for four-processor configurations. Up against midrange servers from the likes of Sun Microsystems and HP, this represents a potentially attractive price.

What's There to RISC?

Price has never been the biggest factor in buying a server, however. Performance—especially reliability—comes first. The 200-MHz Pentium Pro has integer performance highly competitive with RISC chips, and coupled with competent memory, I/O, and mass-storage subsystems, it does well as a database server.

Testing with the industry-standard TPC-C database-server benchmark, Compaq has reported results from a 166-MHz quad-Pentium Pro ProLiant system of 5676 transactions per minute (tpmC) running Windows NT 4.0 and SQL Server 6.5 at $136 per tpmC, which is comparable to many low-end and midrange RISC servers. (That system had 2 GB of RAM and 391 GB of hard drive storage.) Testing a similar 166-MHz setup with a Sybase/UnixWare combination, Compaq reports 6186 tpmC.

To operate as servers, these systems must have high availability, something the traditional PC architecture has not been well known for. Intel's architecture provides for some redundancy, such as the ability to run on any number of available processors, but leaves it up to system vendors to complete the picture.

While neither vendor offers a totally redundant design, both ALR and Compaq implement reliability features formerly found only on more expensive systems (see the features table on page 163) and offer options like redundant power supplies. ALR's power-supply option has load

COMPAQ PROLIANT 5000



RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★
PERFORMANCE	★★★★★

sharing and separate power cords so you can power them from different sources; Compaq's has a single power cord.

Both vendors offer high-performance, hot-pluggable RAID options. They provide the systems with built-in sensors to monitor operating temperatures and catch failure of critical components (e.g., fans and power supplies). Compaq's Insight Manager and ALR's InforManager software provide extensive and sophisticated abilities to notify system administrators of problems.

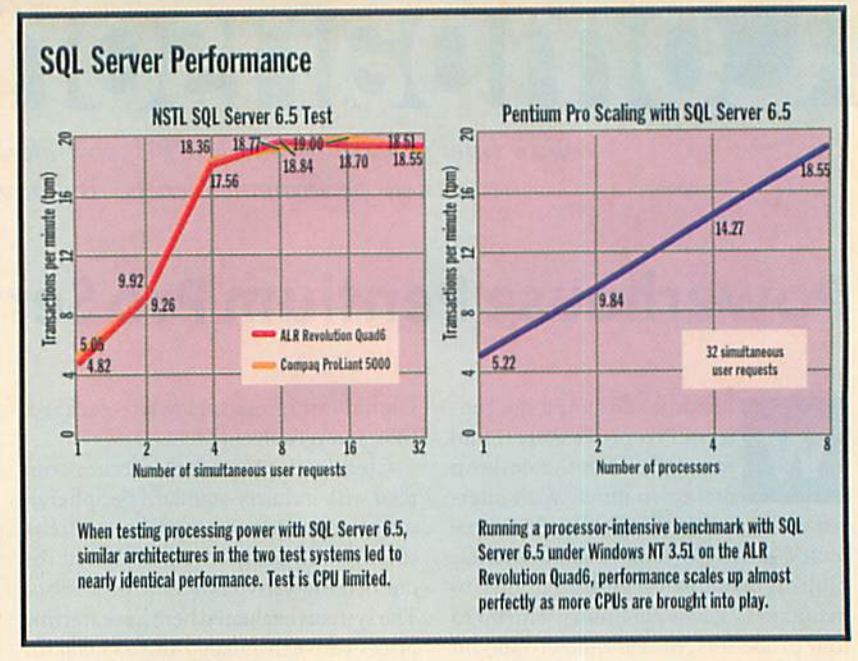
Compaq takes monitoring a step further with its Machine Check Architecture, which monitors drives and memory for degrading function. The ProLiant 5000 monitors hard drives for soft errors, and system memory and the processor's L2 cache for single-bit errors. Compaq's NT hardware abstraction layer (HAL) provides hooks so that Insight Manager can pick up on problems, and its Prefailure Warranty covers replacement before parts actually fail. *continued*

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

ALR Revolution Quad6

ADVANTAGES
+ Lower price
+ Generous expansion capabilities
+ Informative LCD front panel

DISADVANTAGES
- SIMM memory



When testing processing power with SQL Server 6.5, similar architectures in the two test systems led to nearly identical performance. Test is CPU limited.

Running a processor-intensive benchmark with SQL Server 6.5 under Windows NT 3.51 on the ALR Revolution Quad6, performance scales up almost perfectly as more CPUs are brought into play.

ALR's Revolution Quad6 offers more expansion room than Compaq's ProLiant 5000, similar performance, and a set of reliability and security features somewhat less sophisticated than the ProLiant's, but at a price that's around $2500 lower for a comparable configuration. It's a large, wheeled, double-wide unit with plenty of space for storage devices and a unique front-mounted touchscreen LCD panel that displays the status of critical hardware. The panel, which you can easily use without instructions, includes monitoring for CPU status, RAM status, hard drive activity, fan rpm (all 12 of them), temperature (four processors and ambient case temperature), voltage levels at key points on the system board, hardware locks, and system firmware and BIOS.

The motherboard occupies the right half of the system, and the 11 5¼-inch drive bays and power supplies fill the left side. Our test unit had dual 575-W power supplies. The two side-access panels secure with locks. Locking snap-shut doors cover the drive-bay area, and the hot-plug drive cage has its own lock. With eight PCI and eight EISA expansion slots (one shared), the system board is large. The four processors mount in zero-insertion-force (ZIF) sockets for easy upgradability, and the single memory card, held in place with metal braces, takes up to 2 GB of SIMMs. Ours came with 256 MB of 60-nanosecond memory.

The system we tested came with three 2.15-GB, 7200-rpm Conner Fast-Wide SCSI-2 3½-inch hard drives mounted in the hot-swap cage and attached to a single-channel ALR Adac RAID caching controller with 8 MB of cache memory. (We configured it as three separate unstriped volumes for testing.)

ALR provides hardware system management with the aid of the InforManager, a package that includes applets for NT and NetWare. Our test system also included optional diagnostics for power supplies and the RAID caching controller. We found that the graphical configuration software for the controller was easy to use, but it's not quite as appealing as Compaq's.

We found the LCD panel useful when we first started the Quad6. The system emitted a loud, high-pitched tone when we turned it on. It booted properly, however, so the problem was not readily apparent. The panel allowed us to disable the alarm sound and indicated a faulty power supply. An examination inside the system revealed there were two complete identical power systems, powered from two electrical jacks (one was hidden by a sticker). Plugging in the second cord fixed the problem.

In our SQL Server performance testing, the ALR machine provided processor/memory performance identical to the ProLiant's. Its reliability features aren't quite as robust as the ProLiant's, but given the price difference and greater expansion room, you may find the Revolution Quad6 the best deal of any quad-Pentium Pro server.

TECH FOCUS | ARCHITECTURE

Intel's Orion

Intel designed the Pentium Pro for servers as well as desktop workstations, but it's the 82450 chip set (aka Orion), the GX version in particular, that creates Intel's server architecture. All quad-Pentium Pro servers use the 82450GX, and that explains the many design similarities between the Revolution Quad6 and the ProLiant 5000—even though both ALR and Compaq designed their own system boards to get out ahead of the pack (as did Intergraph and Digital Equipment).

Specifically, the GX version of the chip set provides the error-correction-code (ECC) protection for data bus and system memory (up to 4 GB), along with parity protection on the Pentium Pro address and control buses. It also provides for dual, peer PCI buses, which doubles the number of PCI cards a system supports, and four-way interleaving on a 256-bit memory bus (288 bits with ECC).

It's important to configure your quad-Pentium Pro server with the correct RAM modules for two reasons. First, an 82450 bug can cause data corruption if you install certain size combinations of memory modules. Fortunately, both the ALR and Compaq BIOS programs detect problem combinations. Compaq has also gone to some length to provide a good variety of memory upgrades that all work safely. Second, if you stick in a combination of memory modules that forces the system to drop to a two-way interleave (impossible with the ProLiant 5000), the memory bandwidth drops to half at 128 bits and you take a big performance hit.

Compaq ProLiant 5000

ADVANTAGES
+ Highly developed hardware diagnostics
+ Prefailure diagnosis and warranty
+ DIMM memory

DISADVANTAGES
- Higher price



The Compaq ProLiant 5000 arrived with a seven-bay drive cabinet ($1229) of almost the same size as the ProLiant itself, though it didn't have to. The four hot-pluggable drives could all have fit in the main system. Instead, two drives occupied each cabinet. Combined, this provided comparable space to the ALR system alone. The two cabinets connected with a single SCSI-2 cable attached to a Compaq Smart-2 Array Controller/P PCI card. By connecting multiple drive cases to the ProLiant, you can store up to 361 GB on hot-swappable hard drives.

The tested system included 256 MB of 60-ns dual in-line memory modules (DIMMs) protected by the ECC functionality provided by the 82450 chip set. The chip set calculates the 8 ECC bits necessary for 64-bit data and stores them in the parity bits in parity memory. Thus, you don't have to pay more for actual ECC memory modules. The ProLiant's twin memory cards hold a maximum of 2 GB and will be able to hold 4 GB when larger DIMMs become available.

The system board incorporates a dual, peer PCI-bus architecture with seven PCI slots and three bridged EISA slots (two shared). The ProLiant 5000 incorporates a bus-utilization monitor for examining bus traffic on the two PCI buses and will warn of suboptimal bus loading.

The four 200-MHz Pentium Pro processors were paired on two 64-bit CPU cards. The CPU cards are mounted in the system with physical support from a removable metal mounting bracket, which ensures that the cards are installed and positioned properly. Each card supports two CPUs, along with up to three power modules for regulating power from the power supply to the CPU. The third module ($295) is redundant. It can switch over to either CPU if needed.

You can add a redundant voltage-regulator module (VRM) to back up the modules that regulate system-board voltage should they fail or go out of tolerance. The system can map out a failed CPU

PENTIUM PRO SERVER FEATURES

	ALR Revolution Quad6	Compaq ProLiant 5000
PROCESSOR/MEMORY		
CPUs	Four 200-MHz Pentium Pros (512 KB of built-in L2 cache memory)	Four 200-MHz Pentium Pros (512 KB of built-in L2 cache memory)
Motherboard design	ALR	Compaq
Intel PCI chip set	82450GX	82450GX
RAM as tested/maximum (speed, package)	256 MB/2 GB (60-ns SIMMs)	256 MB/2 GB (60-ns DIMMs)
Memory bus width/speed	256 bits/66 MHz	256 bits/66 MHz
Memory interleave (as tested with 256 MB of RAM)	Four-way	Four-way
MASS STORAGE		
Hard drives	Three 2.15-GB, 7200-rpm Fast-Wide Conner CRX2000D72 SCSI drives in ALR internal Smart Quick Hot swap cage	Four 4.3-GB, 7200-rpm Fast-Wide Seagate ST15150W Barracuda SCSI drives in hot-swap modules (two in ProLiant, two in external cabinet)
Drive controller tested	ALR Adac one-channel PCI SCSI RAID controller (8 MB of cache memory)	Integrated 32-bit dual-channel Fast-Wide SCSI-2 controller and Smart-2 Array Controller/P (4 MB of cache memory)
Drive test configuration	Three physical volumes (no RAID)	Four physical volumes (three used, no RAID)
CD-ROM drive	4×IDE	4×SCSI-2
Hard drive bays	11 5¼-inch bays (two used by three-drive hot-swap cage for 3½-inch drives)	Four 3½-inch hot-plug bays; three 5¼-inch bays (two taken by floppy and CD-ROM drives)
Total storage capacity	32 GB with 15 hot-pluggable 3½-inch drives	17.2 GB internal, 361 GB in external cabinets with hot-pluggable 4.3-GB drives
EXPANSION INTERFACES/PORTS		
Expansion slots	Eight PCI (dual, peer PCI buses), eight EISA (one shared)	Seven PCI (dual, peer PCI buses), three EISA (two shared)
Built-in SCSI	None	Integrated PCI Fast-Wide, internal and external
Serial/parallel (IEEE-1284)	Two/one	Two/one
Internal EIDE	Primary and secondary	None
Graphics card/RAM	Paradise Bali 64 PCI/2 MB	Integrated Cirrus/512 KB
NETWORKING		
Network card	ALR E-Net 32/110 Fast Ethernet PCI card (Cogent EM110)	Compaq NetFlex-3 Fast Ethernet PCI card
RELIABILITY/SECURITY		
Power supply	575-W supply with optional 575-W redundant supply (installed) with load sharing and dual cords	488-W supply (redundant power-supply upgrade available)
ECC protection	System bus and memory	System bus and memory
Hardware failure detection/notification	Temperature, fans, CPUs, power	Temperature, fans, CPUs, power
Prefailure notification	None	Drives, memory, processor's L2 cache memory
Other reliability features	None	Optional redundant voltage-regulator modules, built-in fail-over with second network card, fail-over on boot processor
Security	Locking cabinet, BIOS passwords, open cabinet notification, keyboard disable switch	Locking cabinet, BIOS passwords, open cabinet notification
PRICING/SUPPORT		
Price (as tested)	$32,514	$35,000 (projected street price with external drive cabinet)
Included software	Windows NT 3.51, SQL Server 6.0 (tested with 6.5), and ALR InforManager	Compaq SmartStart configuration software with Insight Manager
Lifetime technical phone support	Yes (M-F, 6-6; Sat., 7-1)	Yes (24 hours every day)
Warranty	Five years on system components/three years on labor and peripherals; one year on-site for $10; other options available	Three-year on-site limited warranty; other options available
Inquiry number	1091	1092

Testing SMP with SQL Server 6.5

How do you test a symmetric-multiprocessing (SMP) quad-processor server when you don't have the resources to configure a full-blown TCP-C setup? We did it by focusing on processor/memory performance. Our SQL Server test measures a server's processing power in the context of a decision-support or data-warehouse application. Posing complex SQL queries to a cached database, it uses all available memory and CPU power, but negligible disk and network I/O.

We requested test systems configured accordingly—four 200-MHz Pentium Pro processors (512 KB of L2 cache memory), 256 MB of RAM, but only three or four hard drives installed on a single SCSI channel—and set them up with Windows NT 3.51 and SQL Server 6.5. Connected through a 3Com LinkBuilder FMS 100 Fast Ethernet hub, a single 200-MHz Pentium Pro AST Bravo served as a client machine with up to 32 simulated users. The test launched a separate process for each user plus an additional thread to monitor its progress. The test client application was a Win32 console application that uses the standard Microsoft Foundation Classes (MFC) Open Database Connectivity (ODBC) classes.

We kept the database size under 200 MB so that it would cache effectively on a server that has 256 MB of RAM. We configured SQL Server as would be done for a dedicated corporate data-warehouse server: 128 MB for database buffers, 96 MB for a temporary database, and 32 MB left for NT and code space. (The 96-MB temporary database is actually larger than is typical, but it benefited the queries used in our test.) The server and client systems used a TCP/IP connection, which is a popular choice for many corporations.

By default, SQL Server 6.5 leaves one processor free so that NT can operate the user interface and any other server that might be running. We configured it to use all processors (a new parameter with version 6.5). As a side effect, when the server hits 100 percent CPU use (almost constantly with our test), no more users can log in. During testing, only four users at a time could log in and get their data. As these user queries completed, the server logged in other users and processed their queries. With the default setting (n-1 processors), the server was much "fairer"; all users could log in right away and their queries returned at approximately the same time. The overall test performance with the default setting, however, is only 75 percent of that using all processors, because SQL Server uses only three of the four processors at any given time.

We stepped through a number of user and processor configurations to see how the machines would scale. Ideally, this test should scale linearly for both the number of users and processors. Earlier ports of both SQL Server and Oracle were suboptimal in this regard; consequently, NT received a bum rap about its supposed inability to scale beyond two processors. The current versions of Oracle and SQL Server put this myth to rest. NT scales nicely with either. Our empirical results with NT were close to the theoretical ideal.

–Jim Hurd *is vice president of R&D at National Software Testing Laboratories (Conshohocken, PA). He developed the SQL Server test used here.*

and work without it, and should the boot processor fail, any of the remaining three CPUs can take over as the boot processor. If you install a second Compaq Ethernet card, it can act as a backup that takes over without data loss in case of a failure in the primary network interface card (NIC).

Compaq includes a software installation package called SmartStart. By booting a new system with the SmartStart CD, you can select the desired OS (NT, NetWare, or SCO Unix), and that OS will be installed and the system optimized for its use, although the optimization won't be as good as that performed by an experienced system administrator.

With performance equal to the Revolution Quad6 with our test configuration, the ProLiant 5000 must justify its higher price with its reliability features and Compaq's support. For applications requiring high availability, that may be enough.

Scaling Up

Our testing with SQL Server (see the text box "Testing SMP with SQL Server 6.5" above) showed no significant differences between the two systems, which is not surprising given the architectural uniformity dictated by Intel's 82450 chip set. We tested the Revolution Quad6 with one, two, three, and four processors enabled, and found that SQL Server performance scaled up nicely under NT 3.51.

For logistics reasons, we tested pure CPU and memory performance under SQL Server and not the capabilities of the mass-storage or network subsystems, which should lead to performance differences depending on the test and what options you pay for. For those companies that have put the substantial time and resources necessary to stage official TCP-C database tests, you can compare their published results on the TCP Web site (http://www.tpc.org).

For truly large applications, memory configuration is an important performance factor. According to Compaq, its high TCP-C results with the ProLiant 5000 would have been substantially lower if they had tested with only 1 GB of RAM. The extra 1 GB allowed for more data caching. Also, at these high memory capacities, Compaq claims an advantage in its DIMM-based architecture. You can't go much higher than 2 GB with SIMMs, because it requires twice as many modules as with DIMMs; you run into mechanical form-factor constraints and increased capacitive load with longer traces, additional buffers, and the 5-V technology needed with SIMMs. (DIMMs are 3.3-V parts.)

In addition, you may not get as good performance at 2 GB with SIMMs as with DIMMs, because the SIMMs' higher capacitive load should create sloppier bus timing that may force the BIOS engineers to set the Pentium Pro's tuning registers for memory timing to use more wait states with high memory capacities. In this regard, ALR is developing a DIMM-based memory card.

Both the ALR and Compaq servers are capable, well-engineered machines with extensive feature sets. Choosing between them comes down to a balance of price versus server availability. If price and expansion capacity are more important to you than high availability, ALR's Revolution Quad6 is the system of choice. But if high availability is critical, price becomes a lesser factor, and that is where the ProLiant 5000's more sophisticated reliability features gain the edge. ∎

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The biggest challenge to running numeric intensive code on CPU's clocked over 200 MHz is building a cache/memory subsystem capable of keeping up with the CPU's numeric units. The 21164's Harvard architecture starts with two 32 deep 64-bit register files, followed by two 8K primary caches and an internal 96K cache. The 21164's external 128-bit data bus gets fed by 2 to 8 MB of Bcache built with 10ns SRAMS. The 256-bit wide interleaved memory subsystem that backs up the Bcache can hold up to 512 MB of DRAM. The coup de grace is the Screamer's PCI bus interface, which can accommodate both 32- and 64-bit PCI add-in cards. The Screamer is the biggest numeric winner Microway has introduced since we made it possible to run an 8087 in the IBM-PC in 1982!

A motherboard by itself does not a system make.

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Review

Laser Printer

Hewlett-Packard delivers a nice workgroup/network printer, along with the brand-new PCL 6. By Robert S. Hummel

A High Five for the Latest LaserJet

They used to say you couldn't go wrong buying an IBM computer. Likewise, you can't go wrong with a Hewlett-Packard LaserJet printer. Model after model, HP delivers great printers.

HP has introduced three new LaserJet 5 printers to replace its popular LaserJet 4 Plus and 4M Plus workgroup printers, and they're all winners. Sporting improved speed and usability, these units have been extensively redesigned to make printing easier from start to finish. The LaserJet 5 also marks the debut of Printer Control Language (PCL) 6, the next-generation printer language that HP claims will deliver faster graphics printing, improved gray-scaling, and a new font-synthesis technology.

The LaserJet 5 is rated at 12 pages per minute and prints at 600 dots per inch. It comes standard with 4 MB of memory and three SIMM slots. The printer has 45 TrueType fonts, and an additional 65 come on disk. Windows-based Font-Smart software helps manage fonts.

Two paper trays are standard: a 100-sheet/10-envelope internal tray and a removable 250-sheet paper tray. An optional 500-sheet assembly costs $299.

You can connect directly to the printer using a parallel or serial port. You can easily add network support by putting an HP JetDirect or third-party network card into the printer. An Infrared Device Association (IRDA)–compliant infrared serial port can be added with a $79 adapter.

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★★
PERFORMANCE	★★★★

The LaserJet 5N is identical to the 5 but comes configured with a JetDirect 10Base-T Ethernet card and HP's JetAdmin software. We tested the 5M, with its standard support for 10Base-T, BNC thin coaxial, and LocalTalk; 6 MB of memory; and Adobe PostScript Level 2.

All these printers use HP's Resolution Enhancement technology (REt), a set of algorithms that instruct a printer to add, remove, size, and position dots selectively to produce smoother text and edges. The LaserJet 5 requires less printer memory than the 4 because of its hardware-aided adaptive data compression.



The LaserJet 5M shows off its user-friendly design...and large footprint.

Usability Improves

HP put a lot of thought into the physical design and usability of this new line of printers. For example, molded-in handles make the 37-pound unit much easier to unpack and move.

The control panel has also undergone a much-needed and well-thought-out redesign. You no longer have to interpret tiny blinking lights or squint at an obscure code on a dim LCD. The LaserJet 5 has a bright, blue-green fluorescent, 16-character display that's easily readable from across the room or down the hall. Up to two 40-character plain-language messages can scroll across the display.

The control panel gives you access to menu choices and eliminates the need to retrace your steps. Make your selections and push the printer's large Go button, and the printer is instantly on-line.

One real improvement is the new Job Cancel button, which lets you instantly stop jobs in progress. Other enhancements include an external paper-level indicator and molded-in numbers to identify the paper trays.

Driving PCL 6

These printers are the first to use PCL 6, HP's newest printer language. HP says PCL 6 is optimized for printing from Win-

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

dows and similar environments. (See the Tech Focus box at right.) HP makes some impressive claims for PCL 6: faster graphics printing, improved quality, better correspondence between screen and hard copy, and smaller print data streams. But we found PCL 6 performance wasn't always what we expected.

HP provides three separate drivers for Windows: standard, enhanced, and PostScript. According to HP, the standard driver is compatible with PCL 5e files and performs best with simple text or mixed text and graphics. The enhanced driver maximizes output for documents with complex graphics. And the PostScript driver provides new functions, such as *n*-up printing (i.e., multiple pages on each output sheet) and watermarks.

We first printed two graphics: a blueprint-style image (mostly lines) and a complex 3-D rendering with shaded polygons and curves. Both were printed via Broderbund's 3D Home Architect. The standard driver significantly outperformed the enhanced driver, by factors of 2 and 4, respectively. Repeating these tests on a faster computer showed smaller, but still large, differences.

HP engineers suggested we try more "business-like" applications, so we printed a file containing two graphics images and a watermark; then a complex WordPerfect 7 text page; and finally three PowerPoint slides. In general, the enhanced driver was about 10 percent faster than the standard driver (see the table "Dueling Drivers" at right).

Output from the two drivers showed differences in size and shading, and the enhanced-driver output matched the on-screen display more closely. The PostScript driver was a little better yet.

The standard driver lets you switch to 300 dpi for printing draft images. The enhanced driver uses the same image resolution and printing speed in both cases; the economy mode saves toner by producing a lighter image.

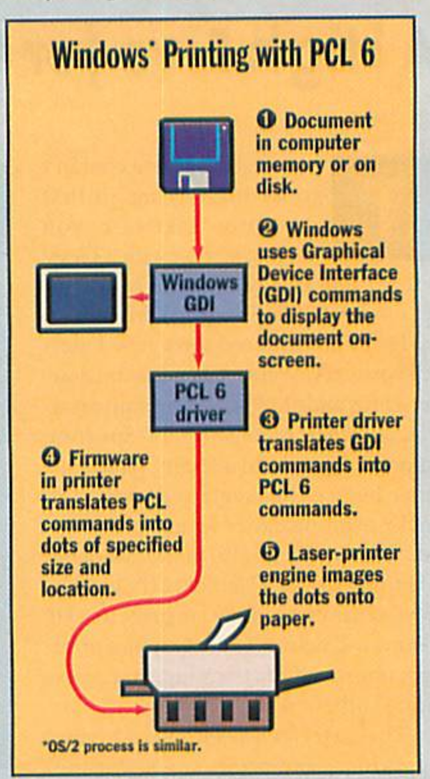
TECH FOCUS | PAGE CONTROL

PCL Turns 6

Each new LaserJet generation has had its own new version of HP's Printer Control Language (PCL), which has become a de facto industry standard. As PCL matured, it got new, enhanced capabilities, such as macros, scalable fonts, complex vector graphics, and color. However, PCL 5 required the printer driver to decompose high-level graphics commands, which consumed CPU time and complicated programming. The driver then shipped the resulting large streams of data to the printer, creating unnecessary network traffic, long spool times, and a long return-to-application time.

PCL 6 repartitions the processing burden using a new interface that's closely aligned with Windows Graphical Device Interface (GDI) calls. The computer spends less time translating GDI calls, so an application should regain control more quickly after printing. Also, the compact PCL 6 commands should improve network throughput. Because PCL 6 mirrors GDI so closely, what you get on paper is much more like what you see on-screen.

PCL 6 can also synthesize fonts from a library of 355 glyphs, which the printer combines into a particular font on demand following special instructions stored as a font description. The end result is an auto-hinted TrueType outline that the printer rasterizes. Using Font Synthesis frees up approximately 850 KB of printer memory.



Dueling Drivers

Print speeds shown in seconds

Type of page	Standard driver	Enhanced driver	PostScript 2.0 driver
Blueprint	10	12	10
3-D rendering	60	107	165
WordPerfect graphics	127	125	181
Complex text	34	31	50
PowerPoint	64	58	54

All tests were conducted on an HP LaserJet 5M with a Dell Dimension XPS P133c with 16 MB of RAM and Windows 95.

Utilities and Networking

The LaserJet 5M ships with software and utilities to support DOS, Windows 3.x and 95, and the Mac. The Status Window utility alerts you to printer malfunctions via a pop-up window. Alternatively, status can be reported using voice alerts.

JetAdmin software supports the setup, use, and management of all printers connected to a network using HP's JetDirect print-server software. Supported network OSes include Windows 95 and NT, NetWare, OS/2 LAN Server, and Unix.

That Certain Something

Besides its high-quality output, ease of use, and rock-solid reliability, this printer has an extra appeal that's very real but hard to define. At BYTE, we work with a steady stream of good laser printers, and we're used to seeing them leave. But the LaserJet 5M will be harder to give up.

It's not the smallest, the least expensive, or the fastest, but it's a winner. Targeted squarely at small office workgroups, the 5M has speed, connectivity, and flexibility, making it a good value for individual and home-office use. **B**

Robert S. Hummel is a computer programmer, consultant, and author. You can reach him at **rhummel@monad.net**.

Chaos Manor



A Little Taste of Crow

Jerry discovers the real explanation for those Cyrix system crashes—in an unlikely place.

The world has gone Internet-mad. Every business from General Motors to Mom's Cookies has an Internet home page, and at Spring Comdex, it was hard to find a product that wasn't labeled as "Internet-ready." There were Internet-ready modems—how could one not be?—Internet-ready keyboards, and even Internet-ready mouse pads.

There was also a lot of cool stuff at Comdex. The thing that impressed me most was a Texas Instruments chip at the heart of a projecting monitor. The chip has thousands of tiny mirrors inside. Each one can move—actual movement, not just electronics—to control what is projected. It's not nanotechnology, but it's one heck of a step in that direction.

BYTE gives the Best of Comdex and Best of PC Expo awards, which means I spend the first two days running around trying to see everything significant. Before the show begins, companies send in forms nominating the new products they're proud of, and we look at all those; but we also look for all the other good stuff that wasn't nominated in advance. We try to pinpoint what's innovative and will have an impact on the industry. I find those long sessions with the BYTE editors about as interesting as anything I do, and I sure learn a lot.

I've been nattering about Comdex because I'm trying to avoid this dish of steamed crow I'm having for lunch, but there's no avoiding it. I had things wrong last month.

I've been testing a Cyrix 6x86-P166, a Pentium-compatible machine that uses Cyrix rather than Intel chips. I had some problems, which I ascribed to Norton System Doctor. Unfortunately, although removing System Doctor cut down on the number of crashes, it didn't eliminate them. There were several kinds of errors, but the most typical was that I'd leave the system running for a couple of hours and come back to find a blue screen with an exception error. Hitting return would make the error go away, and I never had an error that cost data or lost work, but it was worrisome all the same. The Cyrix people were worried, too, because they couldn't duplicate the problem. Cyrix sent units to Symantec and to Larry Aldridge, who does a lot of system testing for me, but neither could duplicate my problems.

I was about to swap my system for the one they'd sent Larry when I realized there was one difference: I was using a smart Ethernet card to connect the Cyrix to my Windows 95/Windows for Workgroups network. Cyrix sent a 3Com EtherLink III Busmaster PCI Ethernet adapter, but since the smart card worked fine—I never had any problems with networking—I never thought my problems could be network-related.

The Cyrix people were worried, too, because they couldn't duplicate the problem.

Still, since Larry couldn't duplicate the problem, and it would be a pain to swap systems, I thought I'd swap network cards. The swap was easy. I removed the smart card and brought the system up so that it would know the card was missing. Then I shut down, installed the 3Com adapter, and booted up. There was a minor start-up glitch, so I had to restart once more, but then Plug and Play worked just fine. The 3Com drivers got installed, the network came up—and my system crashes stopped. After 3 hours, it was clear that there weren't going to be any crashes, so I reinstalled Norton System Doctor. That works fine, too.

I've since exercised this Cyrix in tortuous ways, moving and copying huge blocks of files over to the NT server and back, running QuickTime movies (which used to run jerkily), editing sound files—using Sound Recorder to concatenate several wave files used to be a reliable way to crash the system—and it all works perfectly. I even put in the game This Means War, and while it can crash the Cyrix as it does everything else, it doesn't crash nearly so often as it did on a vanilla Pentium 60. In a word, the Cyrix 6x86-P166 with a standard Ethernet board is fast, reliable, and safe. I like it a lot.

You will note that I haven't named the smart Ethernet card that caused the problems. This is because we want to test it in a PCI slot on Pentafluge, our standard Intel P-60, and then on RacingCow, the Gateway 2000 P5-133XL. I haven't heard any reports of problems with that Ethernet card on Intel systems, so I don't expect any difficulties; but, of course, now I have to see for myself.

Meanwhile, the moral of this story is that the errors you see may not tell you a lot about their cause. We never had a single Ethernet glitch, nor did the system ever crash while doing Ethernet operations, and the error messages we got never said anything about network difficulties.

We have two Intergraph computers: the TDZ-400 and the TD-300. Both systems come in 150- and 200-MHz versions. The TDZ-400 I tested came with dual Pentium Pro 150 chips, and the TD-300 had

a single Pentium Pro 200 chip. Our TDZ-400 has "blue wire" on the motherboard, because this machine was built in August 1995 while the Pentium Pro chips weren't released until November 1. Yours won't have blue wire.

The TDZ-400 has the Intergraph GLZ1 3-D video card, which features OpenGL hardware support. All Windows NT systems have the capability of working with OpenGL, which is the standard API (the way programs talk to hardware) developed by Silicon Graphics for 3-D video applications. The GLZ1 is a fast video card for specific applications—such as engineering modeling and visualization—that use OpenGL and 3-D. Software without OpenGL support works but can't take advantage of the card. The TD-300 has Matrox 2-D video with 2 MB of memory built into the motherboard, and that's more than good enough for most work.

The first thing you will notice about Intergraph machines is that they're *solid.* Whether you have a desktop or a small tower, they're built like battleships. Bill Godbout didn't build machines any better than this back when his CompuPro owned the development-system market in CP/M days. These Intergraphs remind me of Godbout's machines, and those who have been reading this column long enough know that from me that's high praise.

What you get with the Intergraph TDZ-400 and TD-300 is reliable blazing speed, coupled with superb technical support. The machines come with one-year on-site service and a three-year warranty. You also get software support. We had a problem with Premiere 4.0 and called Intergraph. Half an hour later, Intergraph called back to say they'd checked with Adobe: Premiere 4.0 doesn't work with NT. Upgrade to 4.2 and the problem is fixed. You will get the same level of support if you need it.

The system comes with NT in file-allocation-table (FAT) format, so you can install Win 95 as a dual boot if you like; but if you want dual-processor support, you must run it under NT. Disk and CD-ROM drives are fast SCSI-2. There's built-in Ethernet and a dual-height PC Card slot. The sound board is built in and standard, and both speakers and microphone are built into the keyboard. They call it "business audio," but it will play Doom right out of the box.

Clearly, Intergraph's main customer base is people who need engineering workstations and don't want to pay six figures to get them; but there's another market. David Em was one of the earliest fine artists to use a computer—I recommended *The Art of David Em* as the book of the month over a dozen years ago—and quite literally wrote specifications for some of the first programs for generating art displays. We let him play with the TDZ-400. One thing he did was to lay out a compilation of many of his old works. The individual files in the resulting poster were multiple megabytes; the complete image was tens of megabytes. It's beautiful.

What David likes is the blazing speed; he says that the TDZ-400 allows a whole new level of conceptual experimentation. Instead of wondering how something would look, you just try it; you get almost instantaneous response. Many computer-using artists are Mac enthusiasts. For those willing to consider something else, the Intergraph line offers speed, quality, and peace of mind. At a price, of course.

It won't be long before you can integrate Albert Einstein into your wedding photos.

By the end of the summer, Intergraph should have released their new TDZ-310, TDZ-410, and TDZ-610 workstations. Among other things, these machines will have new graphics cards, the fastest of which, Intergraph says, is 2.5 times faster than their best GLZ card.

As I mentioned, BYTE gives out awards at several computer shows. We always make a point of looking at what Intergraph is up to. They're setting new standards for price/performance, not only in computing, but video hardware and software. I haven't seen anything of theirs I don't like.

It used to be that the Mac not only had the best video hardware, but nearly all the fun software like Kai's Power Tools. That's no longer true. Not only are Windows paint programs getting better and easier to use, but MetaTools is porting much of Kai Krause's fun stuff. At Spring Comdex, there were posters extolling Kai's Power Goo, tools for playing with photos taken by Eastman Kodak's newest digital cameras, such as the Kodak Digital Science DC20. For the half dozen people left in the U.S. who did not notice, Eastman Kodak now has digital cameras priced under $350. While they don't have the resolution that more expensive models do, they'll produce quite acceptable 3- by 4-inch photos printed on a color ink-jet printer on Kodak Snapshot Inkjet Paper.

Eastman Kodak also announced a line of higher-resolution digital cameras, including the Kodak Digital Science DC40 and the DC50 Zoom Camera. Better yet, Eastman Kodak, Microsoft, Hewlett-Packard, and Live Picture have developed FlashPix, a new imaging architecture and universal image file format to make it easier for casual users to work with high-resolution pictures on home PCs. BYTE gave FlashPix the Best Technology award at Comdex. It won't be long before you can integrate Albert Einstein into your wedding photos and then smear everything around with Kai's Power Goo. The Mac's monopoly over video is gone, and about the time you read this, you'll be able to use browsers like Netscape Navigator to download new image-processing programs; see http://www.kodak.com for details.

There's another way to get pictures into your machine: get Snappy. This is a small box—they say it's the size of a *Star Trek* tricorder—that attaches to the parallel port of your computer. Feed it video images from a VCR, your video camera, or off cable; invoke the program; and when you want to capture a screen image, do a "snap," and you will have a video image file. You can save the file in BMP, JPEG, TIFF, PCX, and other standard formats. The program generates a true color image and lets you scale it from there. There are three resolutions: 320 by 240, 640 by 480, and 1500 by 1125 pixels; the latter comes with scroll bars since it's larger than most monitors can handle.

Installation takes about 2 minutes. We found that attaching Snappy to the parallel port of RacingCow was a bit of a tight squeeze, so we used a standard 3-foot parallel cable between Snappy and the PC. That turns out to be a convenient way to install it. The unit has its own power supply—a 9-V battery. They think that's good for about 1000 snapshots.

You also get some image software: Gryphon's Morph 2.5, so you can morph

yourself into Albert Einstein or Al Gore, and Fauve Matisse Snappy Edition, a lite version of the paint program (a full upgrade is $39). There's TWAIN (scanner) support, which means you can use Photoshop and other image-processing programs. Since Kodak can read nearly any video file format, you could video yourself, do some morphing or change things with programs like Kai's Power Tools, save the image, and get a Photo CD made of the result. I can envision some interesting slide shows.

Snappy was made by the breakaway members of the old Video Toaster team. They're all mad as hatters; read the manual for details. Like the Video Toaster, Snappy brings something new to the computer world. It's easy to use, interesting, fun, inexpensive, and reliable.

Real programmers have always had contempt for programs written in BASIC.

If you can't think of uses for Snappy, I don't think I want to know you. Highly recommended.

A sort of companion to Snappy is JE Software's PrintScreen. This thing installs in seconds. It gives you the opportunity to save screen images to a file or print them. You can run it as a TSR program so that it works almost anytime, or you can simply invoke it when you need it.

I can't guarantee its compatibility with everything; these TSRs can be tricky. Still, it seems well behaved. Mostly, PrintScreen works.

We've installed it on the Gateway 2000 P5-133XL and the Cyrix 6x86-P166. Both print across the Ethernet. PrintScreen doesn't seem to mind.

Some programs just do what they say they'll do without any fuss. PrintScreen is one of them. Recommended.

Real programmers have always had a degree of contempt for programs written in BASIC. If you ask why, they'll mutter something about memory use, program size, and program speed. BASIC programmers would then point out that at least their programs were up and running during their lifetimes, and the battle would be joined.

Now, BASIC advocates like me can say that with today's new hardware, we don't need to worry about program size and

speed. Memory is below $10 a megabyte. Disk storage is fast approaching $100 a gigabyte. High-end Pentium and Pentium Pro chips run at blinding speeds. What do we care if our BASIC program takes three times as long to run as it would in C++ when we're talking about seconds rather than minutes?

Visual Basic is changing the way we program. It has also spawned a whole new industry of add-on tools. One of the earliest BASIC toolkits was Crescent QuickPak Professional. Crescent was acquired by Progress Software a year ago, and they've continued tool development.

If you're going to learn Visual Basic programming, in my judgment, you should start by getting Visual Basic and then Crescent PowerPak Professional

Knowing how to program doesn't guarantee you'll write good programs.

Edition or Enterprise Edition. This gives you a number of assembly language tools you can call directly into your application; it also gives some source code for complex programs, and that's worth study all by itself. With Visual Basic and Crescent PowerPak, you can build some astonishingly good programs.

The ability to write programs is like the ability to write: knowing how to program doesn't guarantee you'll write good programs any more than knowing how to write assures that you'll write publishable novels. On the other hand, the best way to become a professional writer is to write a lot. I generally tell students they should be prepared to throw away the first million words they write. I suspect it's just as true for programming: the best way to learn is to do a lot of it. BASIC and the Crescent toolkits make it fairly easy to do.

EndNote has long been my favorite bibliography program for scholarly writing. Now, EndNote Plus 2 can be installed as an add-in for Microsoft Word. For those totally addicted to the Web, this is like a Netscape Navigator plug-in.

With the program installed, you can do full bibliographic processing from within your Word document. EndNote Plus 2 does it all: nearly any standard format, including all scholarly citation conventions. Hanging indents, discovery of duplicated citations, and a whole raft of other tools are included.

continued

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EndNote Plus 2 is also a database. You can use it to make and keep libraries of annotated references, so that you will never have to retype title and author for frequently cited works. Formats include APA, Science, ASCE, IEEE, MLA, Chicago A and B, PNAS, Nature, and Turabian. The general database isn't formatted, so you can haul in references from that and then format the document to fit the journal you're submitting to.

If you use Word and you do scholarly publishing, you need EndNote Plus 2. Recommended.

T/Maker is well known for its ClickArt: small, mostly simple, drawings that you can chop and paste into documents and slide presentations as illustrations and a change of pace. The ClickArt Incredible Image Pak 65,000 has illustrations appropriate for holidays, business themes, travel, amusements; you name it.

They also have ClickArt Handwritten Fonts, a CD-ROM of 300 handwritten fonts. No matter what your writing style, neat and proper or fat and sloppy, there's probably a font that looks something like yours. If there isn't, don't despair: with Personal Font, they'll make you a TrueType font and include your signature. Being TrueType, it will be recognized by word processors, so you can even check the spelling. It won't quite be cursive script, because computers need some way to recognize when one letter ends and another starts, but you can make it very close. I haven't sent in my order yet, but I'm tempted. On the other hand, one of their fonts is pretty close, not to what my handwriting looks like, but to what I wish it looked like. Chances are you'll find one like that, too.

They also sell ClickArt Fonts, a CD-ROM of 2500 regular fonts.

With that many fonts, you'll need a real font manager. We saw one at Comdex: Adobe Type Manager Deluxe 4.0 won a BYTE Best of Comdex award. I don't have it yet, but I sure liked what I saw.

With Adobe Type Manager Deluxe 4.0 and the ClickArt discs, you can have all the fonts you ever wanted.

The CD-ROM of the month is My First Amazing World Explorer. Roberta has been having the neighborhood kids test her reading-instruction software. As a reward, we gave one of them this CD-ROM. Here is Roberta's report:

"Thomas, one of our youngest and brightest pals, finishes third grade this year. I installed My First Amazing World Explorer on his home machine about an hour before dinner. This was probably a mistake, because his dad reports that for 45 minutes after that, he never came up for air except to whoop his approval of the product and didn't stop until his mom insisted he come to dinner.

"I happen to know that this is a fairly analytical kid. He is into insects and crawly critters, so I thought he might like the World Explorer CD. It has lots of critters. Now it's his favorite CD, and his sister and parents hardly get to touch the family Mac while he explores.

"First, he signed up for a passport, where he gets to register with a moniker. He chose Stupid Pee (remember he just turned nine, and their favorite genre runs along these lines) and a suitable picture

from the Passport Office. Stupid Pee's face is out of whack, and he has one working eye. Well, you get the idea.

"The home page is Your Bedroom. On the wall is a world map. Click on the map, and you move into a view of the world in beautiful graphics and pictures. At least that is the way Thomas describes them. He really liked the sound effects. For instance, if you click on the top of the map, the CPU says 'North' and makes a whooshing sound. In North America, you can click on a cougar sitting on the crest of the Rockies; his tail straightens out, and his jaws open to let out a mighty roar. Click on a skier, and he slaloms down the peak, makes a jump, and lands back on top of the run.

"When you first click on a new country on a continent, typical music from its history is heard, such as a banjo in the southwest of Texas. Click on a cowboy, and he lassos cattle. Then it moves to text with a couple of sentences about cattlemen. Two hot keys are presented in red, and the text is read to you. Click on the hot key, and a smaller page appears and is read to you in a child's voice.

"This age group is bonkers over stickers, and Thomas is no exception. After reading a selection about a critter, you can select the Sticker icon on that page and the picture replaces an outline in the Sticker book. We clicked on Mexico. It zoomed in closer to the peninsula, where a stone statue appeared. Click on the stone statue holding a stone spear, and the statue launches the spear. 'The spear goes around the world and hits him in the back,' according to Thomas's scenario. When the spear strikes the stone statue, it cracks into pebbles. One of the world's best jokes according to Thomas.

Actually, Roberta had more on My First Amazing World Explorer. I haven't seen such enthusiasm for a kids' CD-ROM in a long time. Clearly recommended.

The book of the month is *Hidden Order: The Economics of Everyday Life* by David Friedman (Harper Business, 1996). One doesn't normally think of an economics book as light and pleasant reading, but David makes it seem so. He also explains most of the assumptions underlying economic theory. If you have any interest in economics at all, you'll find this book both readable and fascinating; and I guarantee you'll learn something from it. David analyzes such things as the length of supermarket checkout lines, whether to change lanes on a freeway, and incidentally something about money and unemployment. He's a former King of the East in the Society for Creative Anachronism, and one of the most interesting people I know.

The computer book of the month is Ed Yourdon's *Rise and Resurrection of the American Programmer* (Prentice-Hall, 1996). Yourdon, you may recall, is one of the pioneers of the computer industry, one of the few consultant gurus to move successfully from mainframes and minicomputers to the microcomputer world. In 1992 he wrote *Decline and Fall of the American Programmer*, which painted a pretty gloomy picture of how offshore companies would eat our lunch. It was particularly depressing for the large number of programmers stuck maintaining COBOL and specialized assembly language programs. His book has been a text in more than a hundred courses.

But now Yourdon writes "all of that was four years ago, and things do change...some of the trends that worried me four years ago have become even more pronounced, but I've been pleasantly surprised to see that in other areas the U.S. software industry has demonstrated a substantial competitive advantage." Ed is too modest to say that his previous book may have helped change some of the trends, but I think it's true.

His views are not always mine, but if you're a programmer or hire programmers, you will be well advised to read this book. [Editor's note: *Edward Yourdon has an article in this issue, "When Good Enough Is Best" on page 85.*]

We're building a Micronix motherboard system, probably a 200-MHz Pentium. I'm not sure what accessories we'll collect for it. Also next month, I'll look at accumulated accessories and software. Stay tuned. I love these little machines.

As usual, you can find more of this column on the BYTE Web site. You might also want to check out http://www.earthlink.net/discontinuity, where John C. Dvorak and I argue critical issues. ■

Jerry Pournelle is a science fiction writer and BYTE's senior contributing editor. You can write to Jerry c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please include a self-addressed, stamped envelope and put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at **jerryp@bix.com**.

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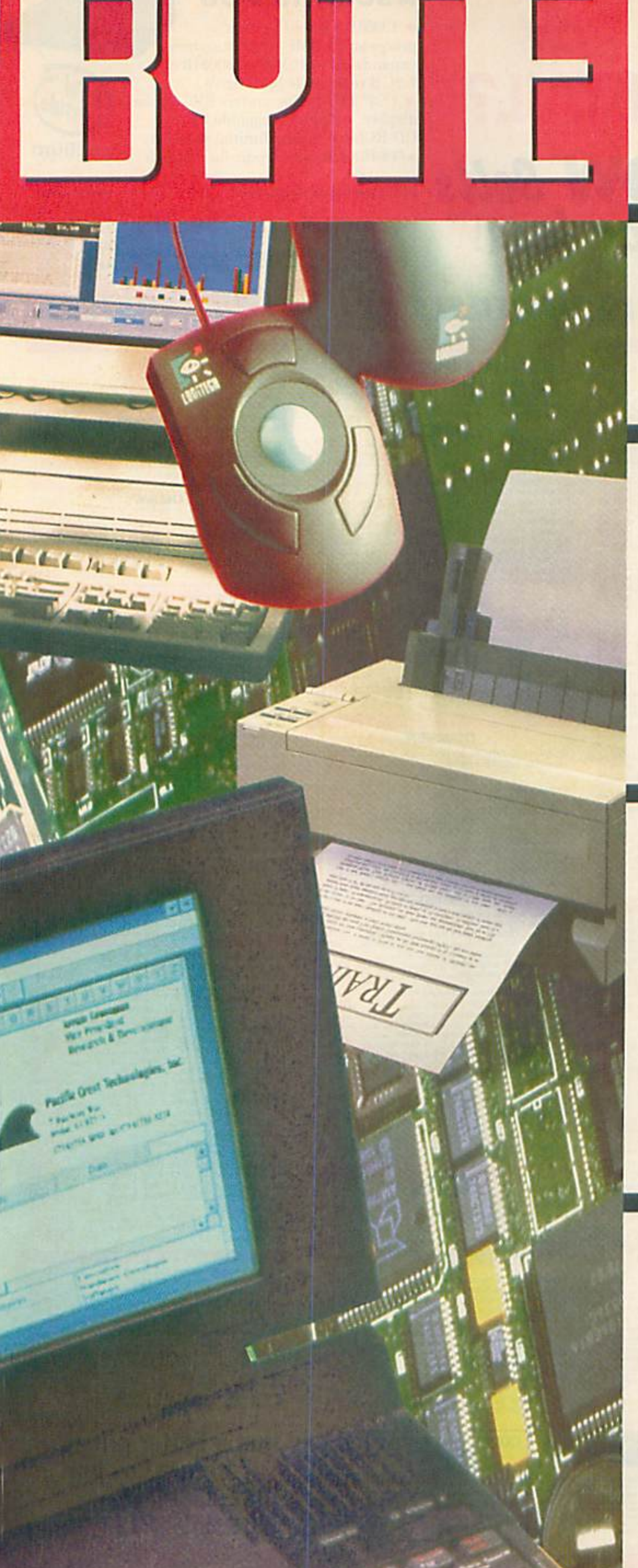
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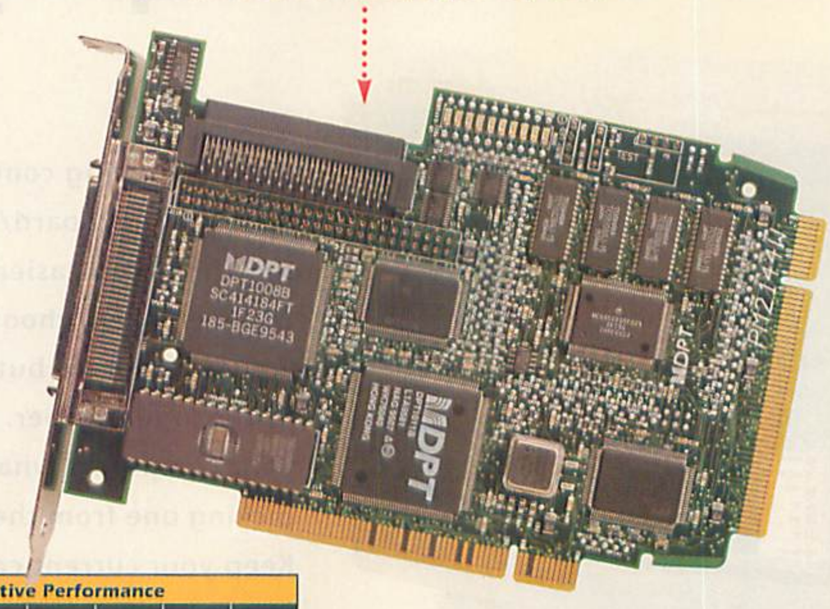


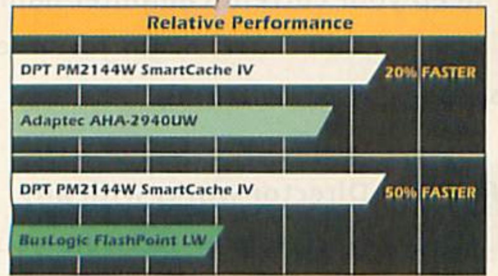
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ST31640A	1.6GB	10.5MS	IDE	245-395
ST32140A	2.2GB	10MS	IDE	295-445
ST51080N	1.08GB	10.5MS	SCSI-2	285-435
ST31051N	1.05GB	9MS	SCSI-2	335-485
ST32430N	2.1GB	9MS	SCSI-2	575-700
ST32151N	2.1GB	9MS	SCSI-2	595-720
ST43400N	3.0GB	11MS	SCSI-2	545-695
ST15230N	4.2GB	9MS	SCSI-2	899-1049
ST410800N	9.0GB	11MS	SCSI-2	1879-2029
SCSI-BARRACUDA-7200 RPM				**INT-EXT**
ST32550N	2.1GB	8MS	SCSI-2	669-874
ST15150N	4.2GB	8MS	SCSI-2	980-1105

MICROPOLIS

FACTORY NEW-5 YEAR WARRANTY				INT-EXT
MC4221	2.05GB	8.5MS	SCSI-2	$549-699
MC4421	2.1GB	9MS	SCSI-2	449-574
MC1936	3.0GB	11MS	SCSI-2	750-899
MC3243	4.3GB	8MS	SCSI-2	850-973
MC1991	9.1GB	10MS	SCSI-2	1839-1964
MC4221AV	2.05GB	8.5MS	SCSI-AV	599-649
MC3243AV	4.3GB	8.5MS	SCSI-AV	939-1089
MC1991AV	9.1GB	10MS	SCSI-AV	1839-2020

FUJITSU

FACTORY NEW-5 YEAR WARRANTY				INT-EXT
M1614T	1.1GB	11MS	IDE	$179-329
M1638T	2.5GB	9.5MS	IDE	349-499
M1638S	2.2GB	10MS	SCSI	469-619
M2934S	4.3GB	10MS	SCSI	869-994

DRIVE SPECIAL! HEWLETT PACKARD 2.1GB SCSI C3725S 9.5MS $495

WIDE SCSI HARD DRIVES

CONNER

FACTORY NEW-5 YEAR WARRANTY				
2105W	2.1GB	8.5MS	5400RPM	$739
4207W	4.2GB	9MS	7200RPM	1231

Seagate

FACTORY NEW-5 YEAR WARRANTY				
ST31230W	1.0GB	9MS	3.5X1"	$439
ST32550W	2.1GB	8MS	3.5X1"	789
ST15230W	4.3GB	9MS	3.5X1"	1042
ST15150W	4.3GB	8MS	3.5"	1059
ST410800W	9.0GB	11MS	5.25"	2019

Quantum

FACTORY NEW-5 YEAR WARRANTY				
XP32150W	2.1GB	8MS	3.5X1"	$649
AGP3430W	4.3GB	8.8MS	3.5"	895
XP34300W	4.3GB	8MS	3.5"	959

MICROPOLIS

FACTORY NEW-5 YEAR WARRANTY				
MC4221W	2.05GB	8.5MS	LP3.5	$699
MC3243W	4.30GB	8.5MS	3.5	939
MC1991W	9.10GB	10MS	FH	1919

CONNER

FACTORY NEW-2 YEAR WARRANTY				INT-EXT
CFS1081A	1.3GB	14MS	IDE	$196-246
CFS1275A	1.3GB	14MS	IDE	207-336
CFS1621A	1.6MB	14MS	IDE	257-407
CFP2105S	2.1GB	9MS	SCSI-2	575-700
CFP2107S	2.1GB	9MS	SCSI-2	644-769
CFP4207S	4.2GB	9MS	SCSI-2	925-1050

WESTERN DIGITAL

FACTORY NEW-3 YEAR WARRANTY				INT-EXT
WDAC2850	850MB	10MS	IDE	$170-320
WDAC21200	1.2GB	10MS	IDE	175-325
WDAC31600	1.6GB	10MS	IDE	245-505
WDAC32100	2.1GB	10MS	IDE	235-385
WDAC32500	2.5GB	10MS	IDE	350-500

Maxtor

FACTORY NEW-2 YEAR WARRANTY				INT-EXT
M71084A	1.08GB	14MS	IDE	$192-342
M71336A	1.3GB	12MS	IDE	200-350
M71626A	1.6GB	12MS	IDE	232-382
M72004A	2.0GB	12MS	IDE	276-426
M72504A	2.5GB	12MS	IDE	350-500

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TOSHIBA

NOTEBOOK DRIVES/1 YEAR WARRANTY ON 2.5"				
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MK1926FCV	810MB	13MS	IDE	320
MK2720FC	1.3GB	13MS	IDE	510

IBM

IBMHDN520	520MB	IDE	$200

Seagate

ST9546AG	524MB	16MS	$295
ST9816AG	810MB	16MS	395

REMOVABLES/OPTICALS

SYQUEST REMOVABLE CARTRIDGE DRIVES

EZ135 135MB IDE Internal	$187
EZ135 135MB SCSI External	199
EZ135 135MB Parallel Port	221
EZ135 135MB Cartridge	20
270MB SCSI INTERNAL	375
270MB SCSI EXTERNAL	495
270MB CART. SINGLES/5 PACK	55-270

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230MB 3.5" OPTICAL DRIVE EXTERNAL	579
230MB CARTRIDGE 1-PACK $35 5-PACK	170

IOMEGA

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ZIP Drive 100MB SCSI	199
Ditto Easy 800MB Travan Tape Drive, Int.	119
Ditto Easy 800MB Travan Tape Drive, Ext	149
Jaz Drive 1GB Internal SCSI-II	399
Jaz Drive 1GB External SCSI-II	499
Jaz Drive 1GB Cartridge	124

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TEAC

1.44MB, 3.5"/ w/brackets	$35-42
1.2MB, 5.25"	45
DUAL FLOPPY 1.44MB & 1.2MB	99

MITSUMI/NEC

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MOUSES

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486 & PENTIUM CPU FANS	$15

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MicroSolutions BACKPACKS

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DISKETTE DRV 1.4MB, 3.5 EXT	175
800TD BACKPACK 800MB TAPE DRIVE	155
BACKPACK 420MB HARD DRIVE	469

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1533	4-8GB TAPE INT/EXT	949-1149
4MM	90MT DAT CART (1/5 PK)	12-55
4MM	120MT DAT CART (1/5PAK)	35-170
	3.5"-5.25" CONVERSION KIT 1533,1536,1534A	39

CONNER

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1534	2.0GB TAPE EXTERNAL	762
1536	4GB TAPE INTERNAL	789
1536	4GB TAPE EXTERNAL	899
1533	4-8GB TAPE INTERNAL	949
1533	4-8GB TAPE EXTERNAL	1149
4MM	90MT DAT CART (1/5 PK)	12-55
4MM	120MT DAT CART (1/5PAK)	35-170
	3.5"-5.25" CONVERSION KIT 1533,1536,1534A	39

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4200I	2GB TAPE EXTERNAL	850
8205XL	3.5-7GB TAPE INT/EXT	1276-1449
8505XL	7-14GB TAPE INT/EXT	1998-2298

IOMEGA

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Bernoulli 230MB Transportable SCSI	525
90 MB/150MB/230MB Cartridge	99

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FOR PC's, WORKSTATIONS, PORTABLES & PRINTERS
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4MB X 9-70NS SIMM 9 CHIP	55
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1MB X 9-100NS 9 CHIP SIMM	20
1MB X 9-80NS 3 CHIP SIMM	25
1MB X 9-80NS 9 CHIP SIMM	25
1MB X 9-70NS 3 CHIP SIMM	25
1MB X 9-70NS 9 CHIP SIMM	25
1MB X 9-60NS 3 CHIP SIMM	25
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16MB X 9-70NS/60NS SIMM	350
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30 PIN NON-PARITY/8 BIT	
1MB X 8-60NS SIMM	20
1MB X 8-70NS SIMM	20
4MB X 8-80NS SIMM	50
4MB X 8-70NS SIMM	50
4MB X 8-60NS SIMM	50
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1MB X 9-100NS SIPP	25
1MB X 9-80NS SIPP	30
1MB X 9-70NS SIPP	35
1MB X 9-60NS SIPP	35
256K X 9-70NS SIPP	15
72 PIN MEMORY	
256 X 36-1MB-70NS	30
512 X 36-2MB-70NS	50
512 X 36-2MB-80NS	50
1X36-4MB-70NS/60NS LOGIC	40
1X36-4MB-70NS/60NS MAJOR	50
2X36-8MB-70NS/60NS LOGIC	75
2X36-8MB-70NS/60NS MAJOR	90
4X36-16MB-70NS/60NS LOGIC	135
4X36-16MB-70NS/60NS MAJOR	165
8X36-32MB-70NS LOGIC	285
8X36-32MB-60NS LOGIC	285
8X36-32MB-70NS MAJOR	295
8X36-32MB-60NS MAJOR	295
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Stealth 64 Graphics, DRAM, 2MB, PCI	175
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Stealth 64 Video, DRAM, 2MB, PCI	175
Stealth 64 Video, VRAM, 2MB, VLB, PCI	299
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ATI Graphics Xpression 2MB, ISA, VLB, PCI	$199
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ATI WinTurbo VRAM 2MB ISA, VLB, PCI	259
Graphics Pro Turbo 2MB ISA, VLB, PCI	289
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9FX 331 1MB DRAM, PCI	$129
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matrox

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Matrox Millennium PCI 8MB	839

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720MB	$895
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524MB	$745
720MB	$895

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2 1/2" REMOVABLE DRIVES

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810MB	$695
1.2GB	$895

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NEC

CDR2225	4 Speed, SCSI, Int/Ext	$125-250
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	Quad 7CD Changer (4Xc)	335

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PX-45CE	4.5X, SCSI, Ext, 256 Cache	355
PX-63CS	6X, SCSI, Int 256 Cache	270
PX-63CS	6X, SCSI, Ext 256 Cache	395
PX-83CE	8X, SCSI, Int 256 Cache	379
PX-83CE	8X, SCSI, Ext 256 Cache	504

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624X	6-CD Changer/4.4 X, SCSI, Int	$289
624X	6-CD Changer/4.4 X, SCSI, Ext	449
1804X	18-Disc Changer 4X, SCSI, Int	1815

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CDS-76	4X Int/Ext IDE	69-224
CDS-76SB	4X Int/Ext SCSI	139-269

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CD-56E	Six Speed IDE Int	$109
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CD-56S	Six Speed SCSI Int	225
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TOSHIBA

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5522	6 Speed IDE Int/Ext	99-249
5401	4 Speed SCSI Int/Ext	134-359
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MITSUMI

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3 PCI Slots, One PCI/ISA Shared, 3 ISA Slots, Four 72 Pin SIMMS Sockets (Supports EDO SIMMS), Triton Chipset, Floppy Port, Two FIFO Serial Ports, One ECP/EPP Parallel Port, Two IDE Interfaces (PIO Mode 3 & PIO Mode 4), Board Size:10"x8.6".

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NEW! INTEL ATLANTIS PENTIUM

3 PCI, 2 ISA Shared, 1 PCI/ISA Slots, 256 Pipeline Burst Cache,4x72 Pin Sockets (up to 128MB),1MB Flash BIOS, Intel Triton Chipset, Integrated PCI/IDE, Intergrated, Super I/O, Integrated ATI Video Card, PC'95 Compliant w/Windows '95 Plug & Play

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INTEL ENDEAVOR PENTIUM

3 PCI slots, 1 PCI/ISA Shared, 2 ISA Slots, four 72 Pin Simm slots (will support EDO RAM), 256K Pipelined Burst Cache On Board (Upgradable to 512K), built-in Creative Labs Vibra 16S Sound Chip (no need for a separate sound card), Floppy Port, Two FIFO Serial Ports, One EPP/ECP Parallel Port, Two IDE Interfaces PIO Mode 3 & PIO Mode 4, Triton PCI Coast Chipset, board Size: 8.6"x13.

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INTEL-486DX4-100		120	225
AMD-486DX2-66/DX4100		120	135-155
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KT946C	32-Bit PCI Fast SCSI-2 Kit	290
KT948C	32-Bit Ultra Wide PCI Fast SCSI-2 Kit	290
KT956C	32-Bit PCI Fast Wide SCSI-2 Kit	329
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KT410A	VESA/IDE Cache Controller	125
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28.8 V.34 ProClass LCD External	299

intel-PUREDATA

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SatisFAXtion 400 Int	299
SatisFAXtion 400 Ext	339

BOCA

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28.8 External V.34	199

Hayes

Accura V.42 FAST 14.4 Int/Ext	$79-99
Accura V.34 FAST 28.8 Int/Ext	159-179
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USRobotics

Sportster 14.4 Internal/External	$95-115
Sportster 28.8/V.34 Internal/External	156-173
Sportster VI 28.8 V.34 Int/Ext	180-219
Courier V.34 28.8/28.8 Int/Ext	339-359
WinModem 28.8 PNP Internal	145

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486SX-25	35	PENTIUM 90	135	486DX2-66	$39	586-120	89
486SX-33	35	PENTIUM 100	165	486DX4-100	49	686-100(P120)	169
486DX-25	75	PENTIUM 120	225	486DX4-120	59	686-100(P133)	199
486DX-33	45	PENTIUM 133	295	486DX4-133	69	686-100(P150)	249
486DX2-50	45	PENTIUM 150	395	586K5-P75	79	686-100(P166)	449
486DX2-66	61	PENTIUM 166	575	586K5-P90	109		
		486DX4-100	105	P-PRO 200	CALL	**CYRIX**	

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1MB X 1-100NS	$6.00
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1MB X 1-70NS	6.50
1MB X 1-60NS	6.75
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256K X 4-80NS	6.25
256K X 4-70NS	6.50
256K X 4-60NS	6.75

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INTEL			
80387SX-16 16MHZ	$59	80487SX-25 25MHZ	195
80387SX-20 20MHZ	59	**CYRIX**	
80387SX-25 25MHZ	59	83D87DX-25 25MHZ	59
80387DX-16 16MHZ	59	83D87DX-33 33MHZ	59
80387DX-20 25MHZ	59	82S8XL 20MHZ	59
80387DX-25 33MHZ	59	**IIT/CHIPS**	
80487DX-33 33MHZ	59	387DX40MHZ	59

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8X8-15	$5.00	32X8-25	8.00
8X8-20	4.50	64X1-15	15.00
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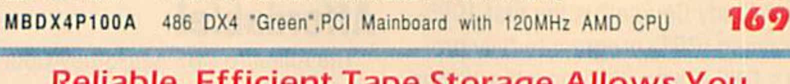
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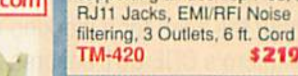
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512 X 36-2MB-80NS	50
1X36-4MB-70NS/60NS LOGIC	40
1X36-4MB-70NS/60NS MAJOR	50
2X36-8MB-70NS/60NS LOGIC	75
2X36-8MB-70NS/60NS MAJOR	90
4X36-16MB-70NS/60NS LOGIC	135
4X36-16MB-70NS/60NS MAJOR	165
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- 486DX2-50 45
- 486DX2-66 61
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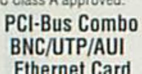
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41769	421000A9B-80	1MB x 9 80ns	28.95

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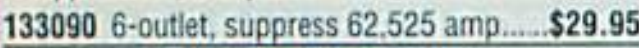
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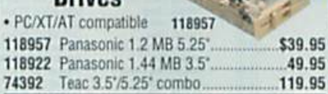
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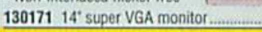
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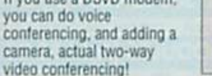
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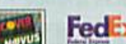
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Bravo 486/25, 486/33	2 Meg Kit	500780-005	68.00
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Tecra 700, 710, 720	*810Meg/1.3Gig*		*729/819*
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Canon Notejet 486-33, 486C, 25 and 33	4Meg/8Meg		79/219
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Canon LBP 430	–	–	39	–	–	–	49	–	–	–	–	–
Canon LBP 860, 1260	–	–	–	39	–	–	69	–	–	94	144	309
Canon LBP4, 4Lite, 4plus	–	–	129	179	–	–	–	–	–	–	–	–
Epson 6000, Action Laser	–	–	–	129	–	–	229	–	–	–	–	–
Epson Action Laser 1100, 1600	–	–	69	70	–	–	99	–	–	199	359	–
Epson Action Laser II	–	–	74	–	173	–	–	272	–	–	–	–
Epson 8000, 1800, 4000, 4100, 4300	–	–	89	–	173	–	–	272	–	–	–	–
Epson 1000, 1500, 5000, 5200	–	–	–	89	–	–	178	–	–	–	–	–
HP 2, 2D+	–	–	–	89	–	–	99	–	–	–	–	–
HP 3, 3D, 3P, 2P, 2P+	–	–	–	*89*	–	–	*99*	–	–	–	–	–
HP 4, 4M, 4Si, 4SiMX	–	–	–	49	–	–	59	–	–	99	–	–
HP 4P, 4PLUS, 4MPm 1600, 1600CM	–	–	19	29	–	–	49	–	–	89	–	–
HP 4L	–	–	34	–	–	–	–	–	–	–	–	–
HP 3Si	–	–	39	–	–	–	69	–	–	119	–	–
HP 5L	–	–	49	74	–	–	89	–	–	199	–	–
HP 5P, 5MP, 4V, 4MV	–	–	19	39	–	–	49	–	–	89	169	–
HP Design Jet 600, 650, 200	–	–	–	39	–	–	49	–	–	109	179	279
HP Deskjet 500, 500C, 510, 550,560	–	*34*	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	39	–	–	49	–	–	109	–	–
HP Paintjet XL300	54	–	–	–	–	–	69	–	–	144	299	–
IBM Laser 4019, 4019E	–	–	–	–	–	139	–	–	–	–	–	–
IBM Laser 4029, 4037	–	–	–	–	–	–	89	–	–	–	–	–
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Lexmark, Optra L, LX, R, RX	–	–	–	–	–	–	59	–	–	94	209	429
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Lexmark Winwriter 200, 400, 600	–	–	29	39	–	–	89	–	–	–	–	–
NEC 90, 290	–	–	–	89	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	79	–	–	–	–	–	–	–	–
Oki 400	–	–	–	79	–	–	–	–	–	–	–	–
Oki 400E, 400EX, 410E, 410EX	–	–	89	109	169	–	189	–	–	–	–	–
Oki 810E, EX, 600E, EX, 610E, EX	–	–	29	39	–	–	79	–	–	119	179	–
Oki 830, 840	–	–	–	89	–	–	–	–	–	–	–	–
Oki 2350, 2450	–	–	Call	Call	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	139	–	–	227	–	–	–	–	–
Packard Bell 9815	–	–	–	139	–	–	229	–	–	–	–	–
Panasonic 4420/4450i	–	–	–	99	–	–	169	–	–	–	–	–
Panasonic 4410/4430	–	–	–	*89*	–	–	*129*	–	–	–	–	–
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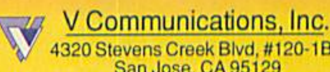
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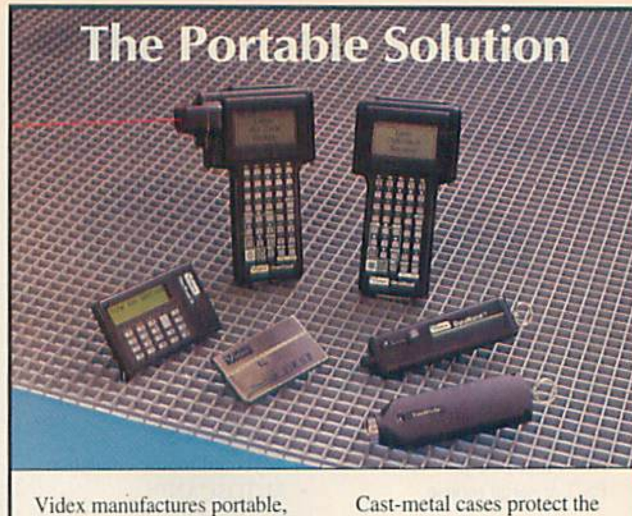
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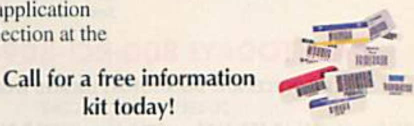
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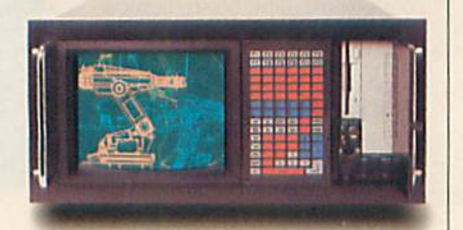
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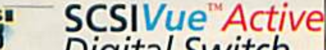
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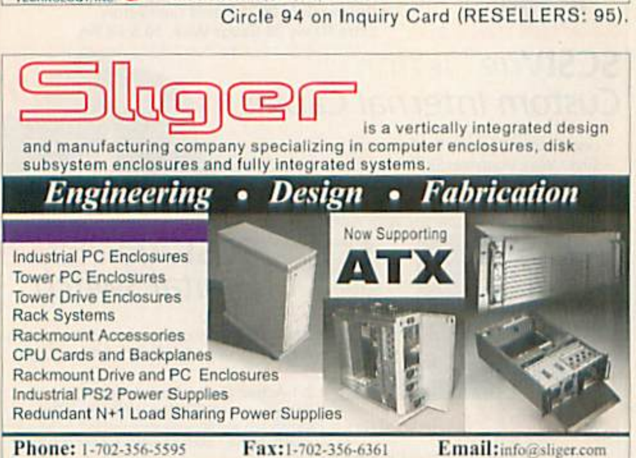
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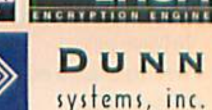


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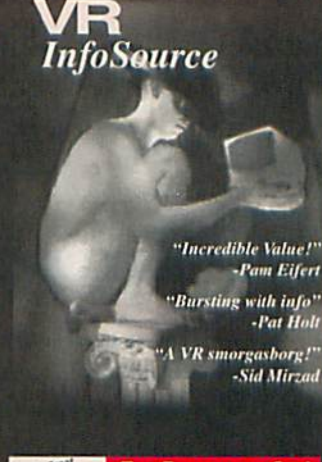
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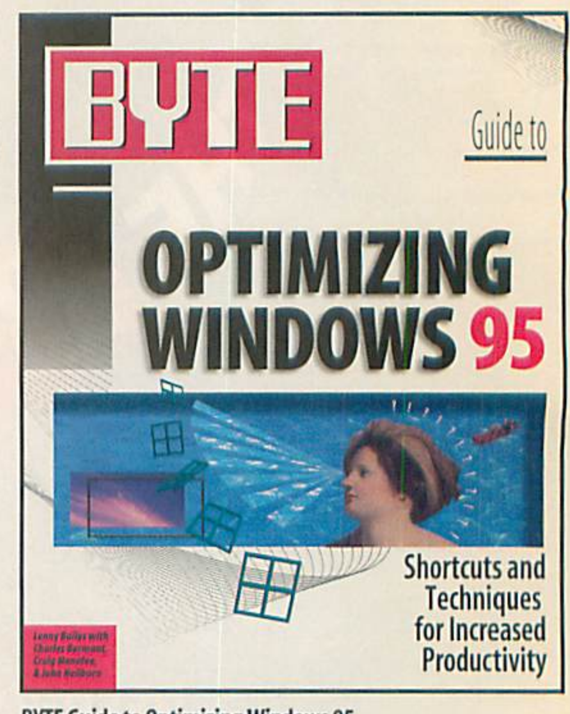
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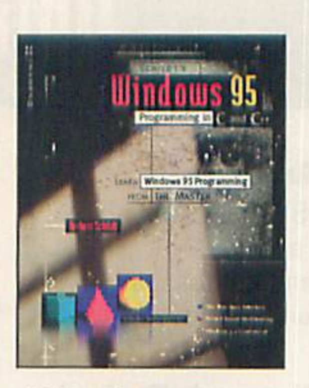
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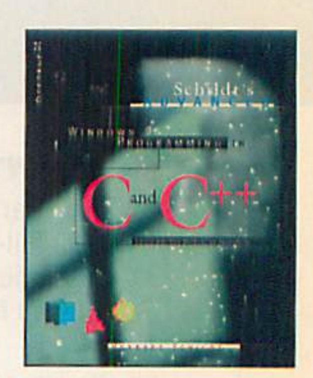
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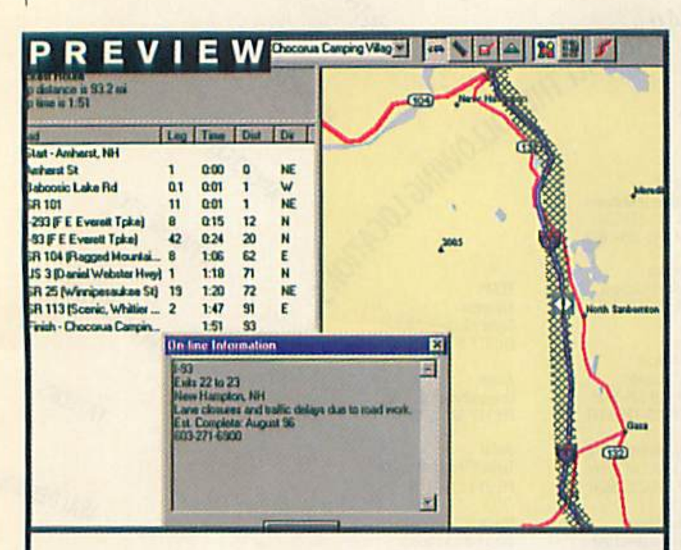
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I found the program's mapping excellent and used it to create directions to a couple of fairly obscure campgrounds in the White Mountains of New Hampshire. The program succeeded with aplomb (when generating directions, you can choose from fastest, most scenic, shortest, and others). Furthermore, you can get detailed information on hotels and other accommodations, such as room rates, from the program. And, perhaps best of all, if you have a GPS receiver and you're using the program on the road with a notebook, DeLorme's Map'n'Go can tell you exactly where you are. **–Dave Andrews**

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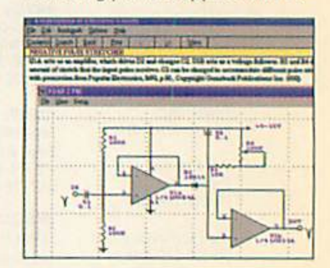
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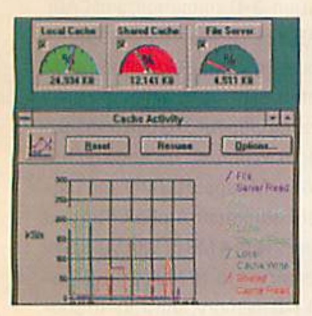
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Compatible with NetWare, NT, NFS, LAN Manager, Vines, and PathWorks clients, Shared LAN Cache

The preview products this month include Gateway's 200-MHz P5-200XL, which introduces SDRAM, a CD-ROM recorder, and a new Intel Triton chip set.



redirects redundant file read requests to a combination of local and shared nonvolatile caches. The program (client software, from $69 per node; servers with a 500-MB nonvolatile cache and a 25-user shared license, from $2995) reduces the time it takes for PC users to load applications and read large files from the network by automatically caching applications software, documents, spreadsheets, scanned images, and other files.
Contact: Measurement Techniques, Inc., Stoughton, MA, (617) 344-6230; http://www.lancache.com.
Circle 1002 on Inquiry Card.

Antivirus for Network Firewalls

A COMPANION PRODUCT TO WEBSCAN, McAfee's antivirus scanner for Web browsers, called WebShield (per gateway, $3995), is compatible with almost all leading network firewalls and Internet gateways. Utilizing two NICs to provide an added barrier to potentially infected traffic, the product scans all network traffic between the cards, alerting administrators to any detected viruses. It can be easily updated each month.
Contact: McAfee Associates, Santa Clara, CA, (408) 988-3832; http://www.mcafee.com.
Circle 1003 on Inquiry Card.

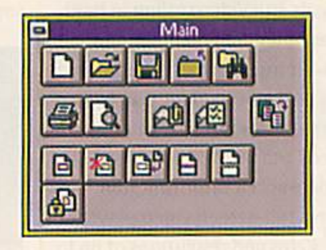
Programming

Mapping and GIS Components

MAPOBJECTS FOR WINDOWS ($1995), an OLE control and collection of more than 35 programmable OLE automation objects, lets you add mapping and GIS capabilities to your applications. You can use MapObjects with programming environments such as Visual Basic, Delphi, PowerBuilder, and Visual C++.
Contact: Environmental Systems Research Institute, Inc., Redlands, CA, (800) 447-9778 or (909) 793-2853; http://www.esri.com.
Circle 1004 on Inquiry Card.

ActiveX Components Suite

THE SHERIDAN COMPONENTS SUITE ON CD-ROM ($349) contains Calendar Widgets, a set of components for visually displaying date- and time-related information in Windows applications; Designer Widgets 2.0, which includes a Dockable Toolbar, Notebook Control, Index Tabs, and FormFX; and Data

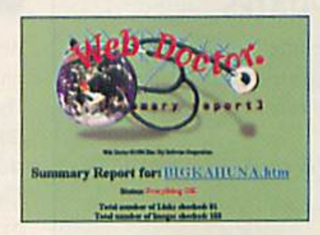


Widgets 2.0, a set of 16- and 32-bit ActiveX Controls that provides a way to develop front ends for database applications.
Contact: Sheridan Software Systems, Inc., Melville, NY, (516) 753-0985; http://www.shersoft.com.
Circle 1005 on Inquiry Card.

The Web

32-Bit Web Authoring and Publishing Tools

WEB OFFICE ($499), INTEGRATED TOOLS for creating and maintaining intranet/Internet Web sites, includes WYSIWYG HTML Author-



ing inside Microsoft Word, Web Doctor, Web Graphics Editor, Web Graphics Library, Help-to-HTML Converter, and Mastering HTML Book.
Contact: Blue Sky Software Corp., La Jolla, CA, (800) 571-9764 or (619) 459-6365; http://www.blue-sky.com.
Circle 1006 on Inquiry Card.

Utilities for the Internet

A SUITE OF INTERNET UTILITIES FOR WINDOWS 95, the Web.Max CD-ROM (about $39.99) includes search capabilities, a news-retrieval feature, an automatic downloader, an Internet telephone, file security, and an Internet start-up kit.
Contact: Berkeley Systems, Inc., Berkeley, CA, (800) 344-5541 ext. 100 or (510) 540-5535; http://www.berksys.com.
Circle 1007 on Inquiry Card.

Groupware Solution for the Web

WEBSHARE (SERVER LICENSE, $1495 PER server) helps you create groupware applications that readily share document-oriented information. Users can submit files to electronic libraries of product literature, sales presentations, and diagrams and photos. WebShare uses SQL to store WebShare data, so you can integrate groupware applications built with WebShare with corporate data stored in SQL databases.
Contact: Radnet, Inc., Cambridge, MA, (888) 723-6381 or (617) 577-9422; http://www.radnet.com.
Circle 1008 on Inquiry Card.

Utilities

Run CD-ROMs Without a CD-ROM Drive

A CD-ROM EMULATION PACKAGE, FastCD Personal Edition for Windows 95 ($24.95) lets you run Windows 95 or NT CD-ROM applications directly off a hard disk, without a CD-ROM drive. You can



run multiple CD-ROM applications off local hard disks, access multiple CD-ROM applications simultaneously off shared images stored on file servers or off other PCs in peer-to-peer fashion, and access CD-ROM applications up to three times faster than from a quad-speed CD-ROM drive.

Contact: Logicraft Information Systems, Inc., Nashua, NH, (800) 880-5644 or (603) 880-0300; http://www.logicraft.com.
Circle 1009 on Inquiry Card.

Windows

Statistical Analysis for Windows

You can analyze data and present the results with StatView for Windows ($595), a 32-bit application that features spreadsheet-like data management, fully customizable graphs and tables, a complete drawing environment, broad-based statistics, linked results and data, and templates.

Contact: Abacus Concepts, Berkeley, CA, (510) 540-1949; http://www.abacus.com.
Circle 1010 on Inquiry Card.

Import Graphics into Microsoft Office

With ImageStream ($69), you can import graphics files into Microsoft Office applications from programs such as AutoCAD, Adobe Illustrator, and CorelDraw without manual conversion. The program also lets you view, edit, and output PostScript files to most printers. It provides 20 extra graphics filters.
Contact: Inso Corp., Boston, MA, (800) 333-1395 or (617) 753-6500; http://www.inso.com.
Circle 1011 on Inquiry Card.

Software UPDATES

Here & Now 2.0, a cross-platform file-interchange utility for PCs, offers Windows 95 support, expanded media support, enhanced bidirectional transfer capabilities, and flexible naming conventions. $99.95.
Contact: Software Architects, Inc., Bothell, WA, (206) 487-0122; http://www.softarch.com.
Circle 1012 on Inquiry Card.

The **Diskeeper 1.04** for Windows NT defragmenter is Microsoft BackOffice-compatible, runs on-line, and maintains databases, Web servers, e-mail servers, and other critical applications. For Windows NT Workstation, $125; for Windows NT Server, $399.
Contact: Executive Software International, Inc., Glendale, CA, (800) 829-4357 or (818) 547-2050; http://www.execsoft.com.
Circle 1013 on Inquiry Card.

A GUI builder, **Builder Xcessory 4.0** adds object receptors; support for Sun, Hewlett-Packard, IBM, Digital Equipment, and Silicon Graphics; Java objects and an optimized Java source code generator; an Object Hierarchy Browser; a specialized attribute editor; WYSIWYG development; and visual inheritance. $3200.
Contact: Integrated Computer Solutions, Cambridge, MA, (800) 800-4271 or (617) 621-0060; http://www.ics.com/.
Circle 1014 on Inquiry Card.

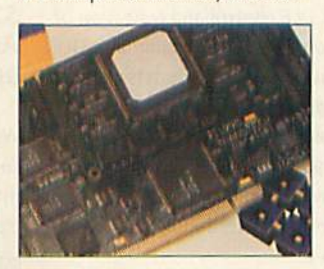
Fax-server software, **RightFax NT 4.50** offers support for NetWare clients, remote-server status monitor and configuration changes, new protocols, user-interface improvements to FaxUtil, and RTF for OCR output. Server license, $1495.
Contact: RightFax, Inc., Tucson, AZ, (520) 327-1357; http://www.rightfax.com.
Circle 1015 on Inquiry Card.

HARDWARE

Add-Ins

High-Performance Host/DSP Interface

An interface card for passing data between Texas Instruments' TMS320C40s and the PCI bus, the TDMB414 (from $1695) comes with a TIM-40 site and two ways of communicating with a PCI host: a C40 COM port to the PCI bus via a 1024-byte FIFO queue and 32 KB of dual-ported memory that con-



nects the C40 global connector and the PCI bus. Fully populated, the TDMB414 can achieve over 500 MFLOPS in only these two slots.
Contact: Transtech Parallel Systems Corp., Ithaca, NY, (800) 836-1012 or (607) 257-6502; http://www.transtech.com.
Circle 1017 on Inquiry Card.

64-Bit Graphics and Video Accelerator

VideoMagic (with 2 MB of EDO DRAM, $159; with 4 MB, $239) uses Trident's TGUI 9682 64-bit graphics engine, which implements TrueVideo scaling in hardware. The graphics engine provides 24-bit true color at resolutions of up to 1024 by 768 pixels and refresh rates of 75 MHz noninterlaced and 96 MHz interlaced. The video-accelerator function features full-screen video playback at 30 fps and resolutions of up to 1600 by 1200 pixels. The card supports video playback for the following formats: CD-I, MPEG, Indeo, Cinepak, Video CD, CD Karaoke, and QuickTime.
Contact: Jaton Corp., Milpitas, CA, (408) 942-9888.
Circle 1018 on Inquiry Card.

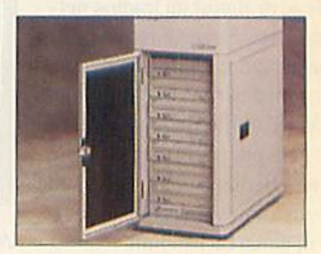
2-D/3-D Graphics Board

For applications in high-end visualization, 3-D animation, and CAD/CAE, the Gloria-M ($1999) includes an S3 Trio64 chip and a dedicated Glint Delta geometry processing chip for 3-D performance under Windows 95 and NT. The Gloria-M supports Intel and Digital Equipment Alpha CPUs and comes with 4 MB of VRAM display memory; 4 to 16 MB of DRAM local 3-D memory; and a 30- to 300-kHz horizontal frequency.
Contact: Elsa, Inc., San Jose, CA, (800) 272-3572 or (408) 935-0350; http://www.elsa.com.
Circle 1019 on Inquiry Card.

Peripherals

CD-ROM Arrays for Mac Networks

Three CD-ROM arrays for Macintosh networks feature Smart SCSI CD boards that map seven CD-ROM drives to a single SCSI ID. The CD Tower-7Mac (about $3795), the CD Tower-14Mac (about $6595), and the CD Tower-21Mac (about $12,995) provide access to users across Mac networks with up to 4.5, 9, and 13.6 GB of CD-ROM-based data, respectively. You can choose between quad- and six-speed CD-ROM drives.



Contact: Procom Technology, Irvine, CA, (800) 800-8600 or (714) 852-1000; http://www.procom.com.
Circle 1020 on Inquiry Card.



Gateway P5-200XL
$3899

Circle 1016 on Inquiry Card.

Gateway 2000, Inc.
North Sioux City, SD
(800) 523-2000
(605) 232-2000
fax: (605) 232-2023
http://www.gw2k.com

Next-Generation Gateway Today

Gateway's new 200-MHz Pentium-based P5-200XL provides more than just the latest Intel processor for power users and early adopters. The P5-200XL also introduces several new technologies that you'll be seeing more of over the next year, including the emerging SDRAM, a standard CD-ROM recorder, and the latest Intel Triton (430VX) chip set. The P5-200XL also includes 512 KB of pipelined burst SRAM cache memory, an eight-speed CD-ROM reader, a 2.5-GB Western Digital EIDE hard drive, a 2-MB Matrox Millennium graphics accelerator, a 17-inch Vivitron monitor (15.9 inches viewable), a 28.8-Kbps Telepath fax modem, an Ensoniq 16-bit wave-table sound card, and Altec ACS-400 speakers.

The P5-200XL is Gateway's first system to include SDRAM (expandable to 64 MB of RAM). SDRAM will be a standard feature in many systems by 1997, because it provides better performance than EDO RAM at the higher clock speeds of future processors. Thanks to the 64-bit DIMM, you can upgrade memory with just a single module, compared to the two 32-bit-wide memory modules you would have to buy if the P5-200XL used SIMMs. The bundled Panasonic CD-ROM recorder (double-speed write/quad-speed read) includes Corel's CD Creator software. The now-standard CD-ROM recorder lets you burn your own CDs to use as a storage medium or to foster information exchange among workgroups. Without the CD-ROM, the system costs $599 less.

The results of benchmark tests demonstrate that this system offers an extensive performance advantage over past systems. The P5-200XL, with 16 MB of RAM and the above configuration, scored an overall rating of 149 in Bapco's brand-new SysMark/32 for Win 95 and NT applications benchmarks, compared to 93 for a 90-MHz Dell. **–Jason K. Krause**

Integrated Scanning Keyboard

Combining a Windows 95 keyboard with the PaperPort hardware/software system into a single integrated device, the PaperPort ix (about $349) provides Visioneer's proprietary SharpPage contrast-enhancement technology, 8-bit gray-scale scanning, and support for up to 400-dpi resolution.



Contact: Visioneer, Inc., Palo Alto, CA, (800) 787-7007 or (415) 812-6400; http://www.visioneer.com.
Circle 1022 on Inquiry Card.

100Base-T Media Converter

The Model 372 (from $349), a 100Base-T-to-fiber media converter provides a low-cost method of increasing the distance between 100Base-TX-compliant LANs.



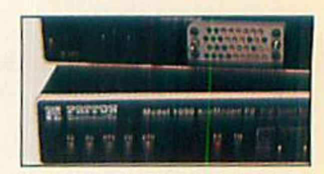
Contact: TeleByte Technology, Inc., Greenlawn, NY, (800) 835-3298 or (516) 423-3232; http://www.telebyteusa.com.
Circle 1024 on Inquiry Card.

Internal ISDN Modem

The Supra NetCommander ISDN modem ($299) integrates a 128-Kbps plug-and-play ISDN modem with an analog port to ring up to three telephones, fax machines, or modems and support for Multilink-PPP with bandwidth-on-demand. The package includes Diamond's AutoISDN application for ISDN configuration and monitoring, Microsoft's ISDN Accelerator Pack for Windows 95, and Microsoft's Internet Explorer. *Contact: Diamond Multimedia Systems, Inc., San Jose, CA, (800) 727-8772 or (408) 325-7000; http://www.supra.com.*
Circle 1021 on Inquiry Card.

160-Kbps Baseband Modem

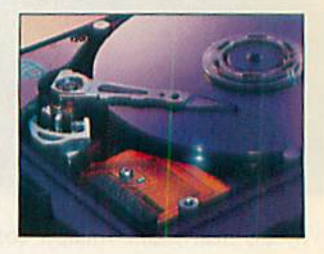
A high-speed baseband modem with interchangeable DTE/DCE interface modules, the Model 1090 KiloModem PS ($695) supports synchronous data rates of from 48 to 160 Kbps, and connects to V.35, X.21, G.703, RS-232, or RS-422/530 hardware interfaces.



Contact: Patton Electronics Co., Gaithersburg, MD, (301) 975-1000; http://www.patton.com/.
Circle 1023 on Inquiry Card.

Four Medalist Hard Drives

Seagate's Fast ATA-2 IDE interface Medalist hard drives (call for prices) include the Medalist Pro 2.5, with 2.5 GB of storage, a rotational speed of 5400 rpm, an average seek time of 11 ms, and an internal data transfer rate of up to 116 Mbps; the 2.1-GB Medalist Pro 2.1, with the same capacity and performance features as the Medalist 2.5; the Medalist 1.7, with 1.7 GB of formatted capacity, a



rotational speed of 4500 rpm, and average seek time of 12.5 ms; and the Medalist 850, with a formatted capacity of 850 MB.

Contact: Seagate Technology, Scotts Valley, CA, (408) 438-8111; http://www.seagate.com.
Circle 1025 on Inquiry Card.

Servers

NT-Based Internet Server

WebCube/NT (from $5995) can host multiple Web sites on the Internet, act as a hub for corporate intranets, or serve as an internal



departmental or companywide communications server. The server operates on a 133-MHz Pentium CPU and includes 32 MB of expandable RAM, high-speed 2-GB SCSI disk and tape drives, internal 3½-inch floppy and CD-ROM drives, 32-bit PCI Ethernet and high-speed serial ports, SVGA video, a three-button mouse, a keyboard, Web-server software, and Internet utilities.
Contact: Pacific Internet, Culver City, CA, (800) 572-2638 or (310) 410-9700; http://www.pacnet.com/.
Circle 1026 on Inquiry Card.

ISDN Communications Servers

The PortMaster 2E Communications Server comes with five ISDN BRI ports (from $3895) or 10 asynchronous serial ports, plus two expansion slots, each of which accepts a five-port BRI module or a 10-port asynchronous module. A fully configured unit can support up to 15 ISDN BRI ports (30 64-Kbps B-channels), 30 115.2-Kbps asynchronous ports, or a combination of the two ($7885). The PortMaster 2i Communications Server ($3495), has five BRI ports and one asynchronous port. You can use each of the 10 64-Kbps B-channels individually, or you can combine them using Multilink-PPP to obtain up to 640 Kbps for high-bandwidth internetworking applications.
Contact: Livingston Enterprises, Inc., Pleasanton, CA, (800) 458-9966 or (510) 426-0770; http://www.livingston.com.
Circle 1027 on Inquiry Card.

Systems

Pentium Desktop PCs

The Z-Station GT 500 Series comes with 100-, 133-, and 166-MHz Pentium processors with Intel's 430HX PCI chip set, ATI's Mach 64 VT 64-bit graphics chip set with synchronous graphics RAM, 16 MB of EDO memory, 256 KB of synchronous pipeline burst cache memory, six SIMM sockets, Mode 4 hard drives, and Windows 95. The Z-Station GT 500 Series also features optional components for videoconferencing and multimedia applications.
Contact: Zenith Data Systems, Buffalo Grove, IL, (800) 533-0331 or (847) 808-5000; http://www.zds.com.
Circle 1029 on Inquiry Card.

Desktop PCs with Intel's Triton II Chip Set

Available in desktop or tower configurations, the Preferred TR2 midsize PCs (from $1500) feature Intel's Concurrent PCI processing architecture for simultaneous



activity on the CPU, PCI, and ISA buses. The systems provide single or dual 100-, 120-, 133-, 150-, 166-, or 200-MHz Intel Pentium processors; 256 or 512 KB of L2 cache memory; SMP power; and a USB port. Six expansion bus slots are available.
Contact: CSS Laboratories, Inc., Irvine, CA, (714) 852-8161; http://www.csslabs.com.
Circle 1028 on Inquiry Card.

167-MHz UltraSparc-Compatible Systems

The UWS1/170E (from $12,500) amd UWS1/170E-SYS (from $17,400) workstations include four 64-bit SBus slots, 20-MBps



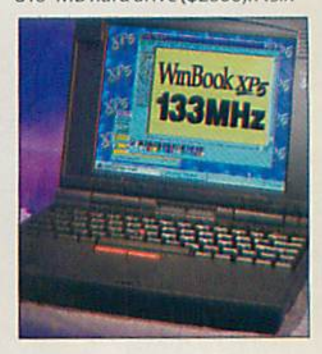
Fast Wide SCSI-2, and 100-/10-MBps fast Ethernet and Media Information Interconnect interface. The UWS1/170E-SYS includes an UltraSparc 1E system board, 32 MB of memory, 16-bit audio, a six-speed CD-ROM drive, a 1.44-MB floppy drive, a hard drive of up to 2.1 GB, Turbo GX graphics, a 17-inch monitor with cable, and Solaris 2.5.
Contact: Integrix, Inc., Newbury Park, CA, (800) 300-8288 or (805) 375-1055; http://www.integrix.com.
Circle 1030 on Inquiry Card.

Windows NT Personal Workstations

Powered by 300- and 366-MHz Alpha 21164 microprocessors, the Alpha XL 300 and 366 incorporate 2 MB of secondary cache memory, a 128-bit memory bus, a 32-bit PCI I/O bus, Fast and Wide SCSI-2 for high-speed disk access, and integrated Ethernet. The workstations support up to 512 MB of memory, and five drive bays supporting a floppy drive, a quad-speed CD-ROM drive, and up to 12 GB of internal storage. An Alpha XL 300 Personal Workstation ($8495) has 32 MB of memory, a 1-GB hard drive, a Matrox Millennium 2-D/3-D graphics adapter, a CD-ROM drive, and a floppy drive. An Alpha XL 366 Personal Workstation ($9995) comes with the same configuration.
Contact: Digital Equipment Corp., Maynard, MA, (800) 842-7027; http://www.alphastation.com.
Circle 1032 on Inquiry Card.

100- and 133-MHz Pentium Notebooks

The WinBook XP5 Pentium 100- and 133-MHz notebooks come with 16 MB of RAM, a 1.3-GB hard drive, a 10.4-inch active-matrix color screen, 256 KB of cache memory, and a 28.8-Kbps fax modem. The entry-level dual-scan XP5 P100 includes 8 MB of RAM, a 540-MB hard drive, a 10.4-inch dual-scan color screen, 256 KB of cache memory, an internal 14.4-Kbps fax modem, and NiMH batteries ($1999; with 16 MB of RAM, $2399). The active-matrix XP5 P100 adds 16 MB of RAM and an 810-MB hard drive ($2999). A six-



speed CD-ROM docking station is also available ($399). You can choose a Lexmark pointing stick, an optional Logitech 19-mm trackball ($29.95), or an optional Alps touchpad ($79.99).
Contact: WinBook Computer Corp., Columbus, OH, (800) 468-2162; http://www.winbook.com.
Circle 1031 on Inquiry Card.

toys

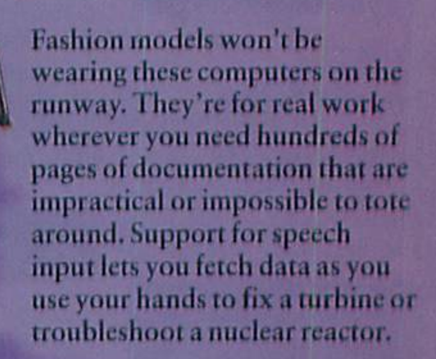
Trekker 2020
about $10,000

Rockwell International
(319) 295-5100
http://www.cacd.rockwell.com
Circle 1103 on Inquiry Card.

Speech Development Kit
$995

Speech Systems
(303) 938-1110
http://www.speechsys.com
Circle 1104 on Inquiry Card.

Wearable Pentium



Fashion models won't be wearing these computers on the runway. They're for real work wherever you need hundreds of pages of documentation that are impractical or impossible to tote around. Support for speech input lets you fetch data as you use your hands to fix a turbine or troubleshoot a nuclear reactor.

A built-in microphone lets you speak to the wearable computer using off-the-shelf speech-to-text programs or custom client/server dictation applications created with tools like the Speech Development Kit from Speech Systems.

The heads-up display from Kopin provides 640- by 480-pixel monochrome output. Images such as architectural plans or documentation for submarines appear inside the unit–this is not a see-through display.

The Trekker 2020 will incorporate a 120-MHz Pentium processor, a 1.2-GB hard drive, 16 MB of RAM, and a Motorola 56000-series digital signal processor (DSP) for improved speech-to-text operation. The system has thermal management hardware to throttle back the clock if the Pentium starts running too hot.

Optional keyboard, if you actually need to type in something.

REMEMBER, THE MONEY YOU SAVE COULD BE YOUR OWN.

200MHz PENTIUM® PRO PROCESSOR
DELL DIMENSION™ XPS Pro200n

- Mini Tower Model
- 64MB EDO Parity Memory
- 256KB Internal L2 Cache
- *NEW* 3.2GB Hard Drive [9.5ms]
- *NEW* 17HS Trinitron Monitor (15.9" v.i.s., .26dp, 1600 x 1200 max. res.)
- *NEW* #9 2MB EDO ViRGE 3D Video Card
- 8X EIDE CD-ROM Drive
- MS® Office Professional with Bookshelf for Windows® 95
- Microsoft® Windows NT®/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty†

★ *Now, Microsoft Windows NT 4.0 Upgrade Coupon included at no extra charge.**

★ *Upgrade to a 4.2GB hard drive, add $125.*

$3499

Business Lease◊: $129/Mo.
Order Code #500320

200MHz PENTIUM PRO PROCESSOR
DELL DIMENSION XPS Pro200n

- Mini Tower Model
- 32MB EDO Memory
- 256KB Internal L2 Cache
- 1.6GB Hard Drive [11ms]
- 15TX Trinitron Monitor (13.7" v.i.s.)
- *NEW* #9 2MB EDO ViRGE 3D Video Card
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- Microsoft Windows NT/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty

★ *Now, Microsoft Windows NT 4.0 Upgrade Coupon included at no extra charge.**

★ *Upgrade to a 3.2GB hard drive, add $149.*

$2499

Business Lease: $92/Mo.
Order Code #500319

200MHz PENTIUM PROCESSOR
DELL DIMENSION XPS P200s

- Mini Tower Model
- 32MB SDRAM Memory
- 512KB Pipeline Burst Cache
- *NEW* 4.2GB Hard Drive [10.5ms]
- 17LS Monitor (15.7" v.i.s.)
- *NEW* Imagine 128 Series 2 Graphics Accelerator with 4MB VRAM
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- AWE32 Wave Table Upgrade Card
- Altec Lansing ACS-31 Speakers
- Microsoft Windows 95/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty

★ *Upgrade to a 17HS Trinitron monitor (15.9" v.i.s.), add $149.*

$3399

Business Lease: $126/Mo.
Order Code #500318

200MHz PENTIUM PROCESSOR
DELL DIMENSION XPS P200s

- Mini Tower Model
- 32MB SDRAM Memory
- 512KB Pipeline Burst Cache
- 1.6GB Hard Drive [11ms]
- 15TX Trinitron Monitor (13.7" v.i.s.)
- *NEW* #9 2MB EDO ViRGE 3D Video Ca
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- AWE32 Wave Table Upgrade Card
- Altec Lansing ACS-31 Speakers
- Microsoft Windows 95/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty

★ *Upgrade to a 17LS (15.7" v.i.s.), add $*

PICTURED SYSTEM

$2499

Business Lease: $92/Mo.
Order Code #500317

166MHz PENTIUM PROCESSOR
DELL DIMENSION XPS P166s

- Mini Tower Model
- 32MB SDRAM Memory
- 512KB Pipeline Burst Cache
- *NEW* 4.2GB Hard Drive [10.5ms]
- 17LS Monitor (15.7" v.i.s.)
- *NEW* #9 2MB EDO ViRGE 3D Video Card
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- AWE32 Wave Table Upgrade Card
- Altec Lansing ACS-5 Speakers
- Microsoft Windows 95/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty

★ *28.8 Data/Fax modem, add $129.*

$2799

Business Lease: $104/Mo.
Order Code #500316

166MHz PENTIUM PROCESSOR
DELL DIMENSION XPS P166s

- Mini Tower Model
- 16MB SDRAM Memory
- 512KB Pipeline Burst Cache
- *NEW* 3.2GB Hard Drive [9.5ms]
- 15LS Monitor (13.7" v.i.s.)
- *NEW* #9 2MB EDO ViRGE 3D Video Card
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- AWE32 Wave Table Upgrade Card
- Altec Lansing ACS-5 Speakers
- Microsoft Windows 95/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty

★ *Upgrade to 32MB SDRAM, add $225.*

$2199

Business Lease: $81/Mo.
Order Code #500315

200MHz PENTIUM PROCESSOR
NEW DELL DIMENSION P200v

- Mini Tower Model
- 16MB SDRAM Memory
- 256KB Pipeline Burst Cache
- 1.6GB Hard Drive [11ms]
- 15TX Trinitron Monitor (13.7" v.i.s.)
- 64-bit PCI 2MB DRAM Video
- 8X EIDE CD-ROM Drive
- Microsoft Windows 95/30 Days Free Support/Dell Mouse
- 3 Year Limited Warranty

★ *Upgrade to a 2.5GB hard drive, add $99.*

★ *Altec Lansing ACS-5 speakers and Sound Blaster 16 PnP sound, add $99.*

★ *3Com EtherLink Interface Combo Card, add $99.*

$1999

Business Lease: $74/Mo.
Order Code #500314

133MHz PENTIUM PROCESSOR
NEW DELL DIMENSION P133v

- Mini Tower Model
- 16MB SDRAM Memory
- 256KB Pipeline Burst Cache
- 1.6GB Hard Drive [11ms]
- 15LS Monitor (13.7" v.i.s.)
- 64-bit PCI 2MB DRAM Video
- 8X EIDE CD-ROM Drive
- 28.8 Data/Fax Modem
- Microsoft Windows 95/30 Days Free Support/Dell Mouse
- 3 Year Limited Warranty

★ *Upgrade to 3 Years of On-site Service;^Δ add $99.*

★ *Upgrade to 32MB SDRAM, add $225*

★ *1.6GB/3.2GB Travan Tape Backup with Accelerator, add $225.*

$1799

Business Lease: $67/Mo.
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- 8MB RAM/540MB Hard Drive
- 256KB L2 Cache
- Options Bay accepts 4X CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery
- PCI Bus with 128-bit Graphics Accelerator
- Integrated 16-bit Stereo Sound
- Smart Lithium Ion Battery
- Touchpad/IrDA-1 Port
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